Real-Time Water Quality Deployment Report

Lower Churchill River Network

May 23 to
June 27, 2013

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Environment and Conservation
Water Resources Management Division

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Prepared by:
Grace de Beer – Environmental Scientist
Department of Environment and Conservation
Water Resources Management Division
Phone: 709.896.5542
Fax: 709.896.9566

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Real Time Water Quality Monitoring

- Department of Environment and Conservation staff monitors the real-time web pages regularly.
- This deployment report discusses water quality related events occurring at five stations on the Lower Churchill River: below Metchin River, below Grizzle Rapids, above and below Muskrat Falls and at English Point.
- There was no instrument deployed at the station on Lake Melville east of Little River. Instrument deployments at this station have been suspended for 2013 because of deployment issues in both 2011 and 2012 that caused significant damage to the instrument.
- On May 23/24, 2013, real-time water quality monitoring instruments were deployed at the five Lower Churchill River Stations for periods of 34 days. Instruments were removed on June 26/27, 2013.

Quality Assurance and Quality Control

- As part of the Quality Assurance and Quality Control protocol (QAQC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.
  - ► At deployment and removal, a QAQC Instrument is temporarily deployed along side the Field Instrument. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments**.** Based on the degree of difference between parameters recorded by the Field Instrument and QAQC Instrument at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

Table 1: Ranking classifications for deployment and removal

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (C)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	<+/-1
pH (unit)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Sp. Conductance (µS/cm)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Sp. Conductance > 35µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/l) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

- It should be noted that the temperature sensor on any instrument is the most important. All other parameters can be broken down into three groups: temperature dependant, temperature compensated

and temperature independent. Because the temperature sensor is not isolated from the rest of the instrument the entire instrument must be at the same temperature before the sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.

- Deployment and removal comparison rankings for the Lower Churchill River stations deployed from May 23/24 to June 26/27 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations, May 23/24– June 26/27, 2013

Churchill River Station and Instrument Number	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River (45707)	May 23, 2013	Deployment	Good	Good	Excellent	n/a†	Excellent
	June 26, 2013	Removal	n/a‡	n/a‡	n/a‡	n/a‡	n/a‡
Below Grizzle Rapids (45699)	May 23, 2013	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	June 26, 2013	Removal	Excellent	Poor	Excellent	Excellent	Excellent
Above Muskrat Falls (47590)	May 24, 2013	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	June 27, 2013	Removal	n/a‡	n/a‡	n/a‡	n/a‡	n/a‡
Below Muskrat Falls (45700)	May 24, 2013	Deployment	Good	Poor	Excellent	Excellent	Excellent
	June 27, 2013	Removal	n/a‡	n/a‡	n/a‡	n/a‡	n/a‡
At English Point (45042)	May 24, 2013	Deployment	Good	Good	Excellent	Excellent	Excellent
	June 27, 2013	Removal	Good	Marginal	Excellent	Excellent	Good

†Comparison ranking unavailable due to dissolved oxygen sensor malfunction on the QAQC instrument 47592 on May 23.

‡Comparison rankings unavailable as the instruments were exposed to air upon removal following a decrease in water level.

- At the station below Metchin River, all parameters ranked 'good' or 'excellent' at deployment except for dissolved oxygen which was not ranked due to sensor malfunction on the QAQC instrument s/n 47592.

  During the deployment period, the instrument became exposed to air as the water level dropped. No comparison rankings were recorded at removal.

- At the station below Grizzle Rapids, all parameters ranked 'excellent' at deployment.

  At removal, temperature, specific conductivity, dissolved oxygen and turbidity all ranked 'excellent' while pH ranked 'poor'.

  For pH the field instrument read a value of 7.06 and the QAQC instrument read a value of 8.22. The discrepancy in these values leading to the 'poor' ranking may in part be caused by the limited time the

QAQC instrument was left to stabilize to the environment or the field or QAQC instrument may not have calibrated correctly in the laboratory prior to the field visit.

- At the station above Muskrat Falls, all parameters ranked either 'good' or 'excellent' at deployment.

  During the deployment period, the instrument became exposed to air as the water level dropped. No comparison rankings were recorded at removal.

- At the station below Muskrat Falls, temperature, specific conductivity, dissolved oxygen and turbidity all ranked either 'good' or 'excellent' while pH ranked 'poor'.

  For pH, the field instrument read a value of 6.06 and the QAQC instrument read a value of 7.15. The discrepancy in these values leading to the 'poor' ranking may in part be caused by the limited time the QAQC instrument was left to stabilize to the environment or the field or QAQC instrument may not have calibrated correctly in the laboratory prior to the field visit.

  During the deployment period, the instrument became exposed to air as the water level dropped. No comparison rankings were recorded at removal.

- At the station at English Point, all parameters ranked either 'good' or 'excellent' at deployment.

  At removal, temperature, specific conductivity, dissolved oxygen and turbidity all ranked either 'good' or 'excellent' while pH ranked 'marginal.

  For pH, the field instrument read a value of 6.94 and the QAQC instrument read a value of 7.88. The discrepancy in these values leading to the 'poor' ranking may in part be caused by the limited time the QAQC instrument was left to stabilize to the environment the field or QAQC instrument may not have calibrated correctly in the laboratory prior to the field visit.

Data Interpretation

- The following graphs and discussion illustrate water quality related events occurring between May 23/24 and June 26/27 in the Lower Churchill River Network.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QAQC protocol. Water Survey of Canada is responsible for QAQC of water quantity data. Corrected data can be obtained upon request.

Churchill River below Metchin River

- The instrument at this station became exposed to air following a significant drop in the water level between May 23 and June 8. Data recorded after June 8, during the time the instrument was exposed, has been removed from the data set and is not included in the following graphs for the station.
- Water temperature ranges from 2.50°C to 8.40°C during the deployment period (Figure 1).
- Water temperature is increasing throughout this part of the deployment period. This trend is expected due to the warming air temperatures in the spring season (Figure 2).

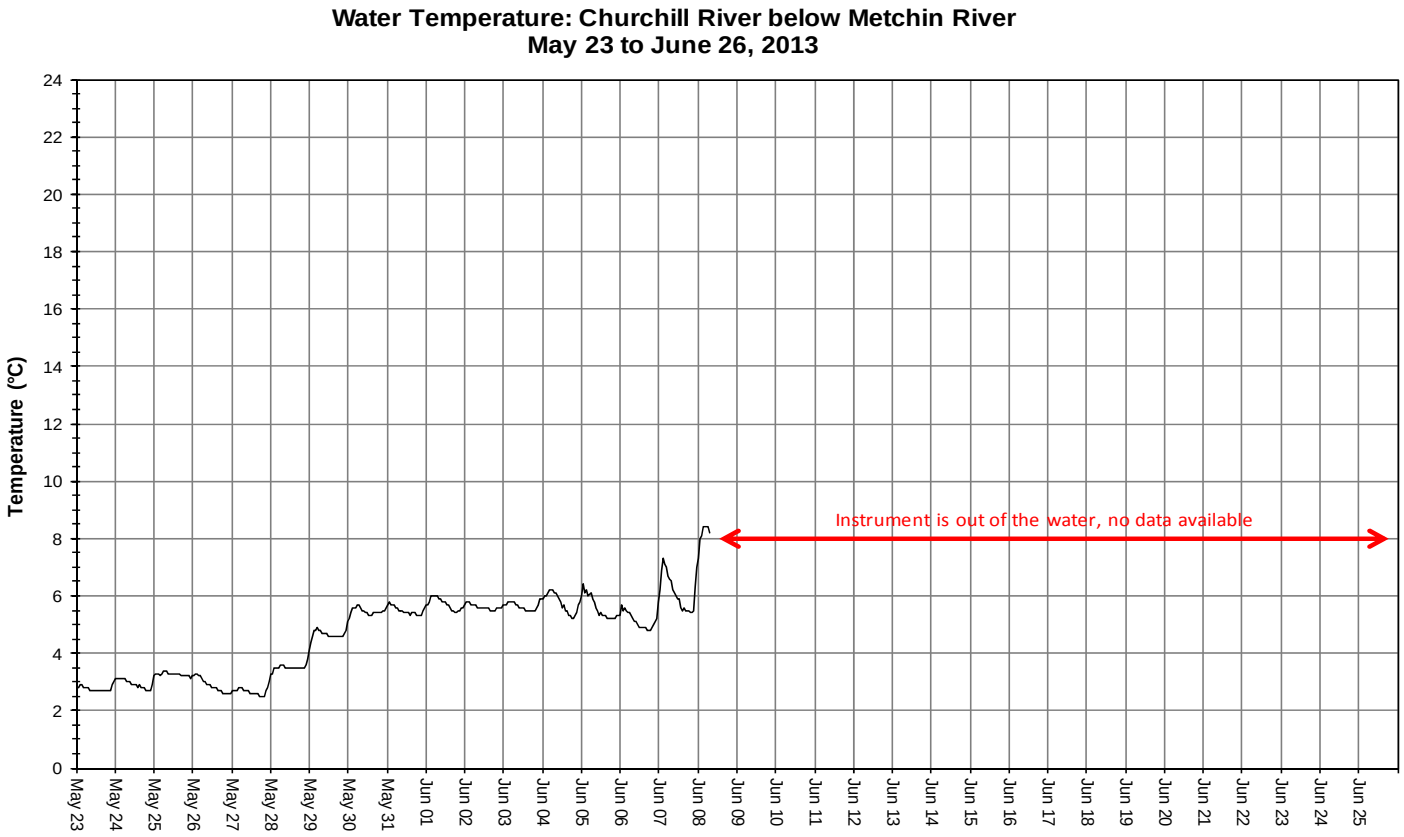


Figure 1: Water temperature at Churchill River below Metchin River

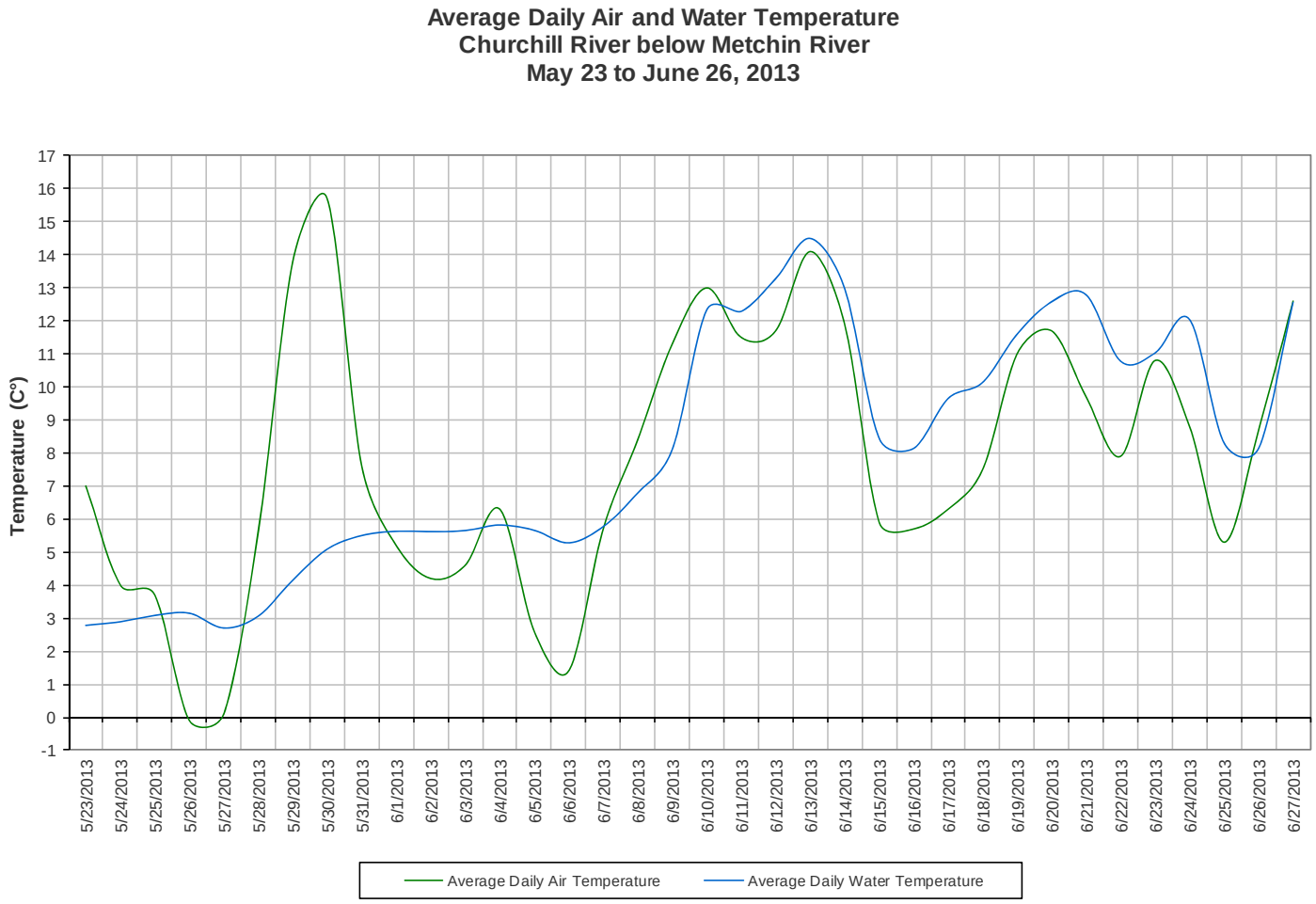


Figure 2: Average daily air and water temperature at Churchill River below Metchin River (weather data recorded at Churchill Falls, NL)

- pH ranges between 6.79 and 7.06 pH units and is increasing slightly throughout the deployment period (Figure 3).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 3).

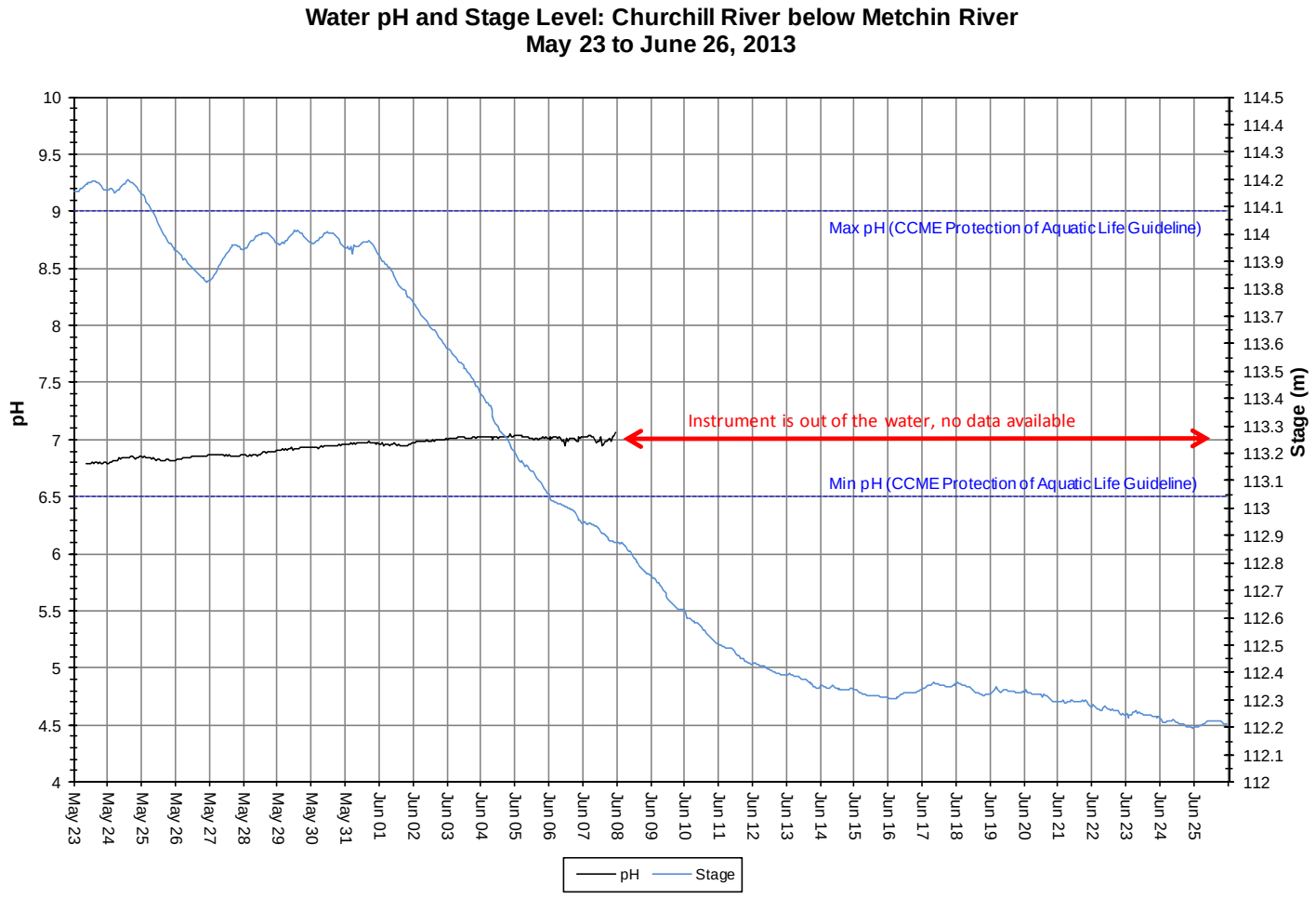


Figure 3: pH and stage level at Churchill River below Metchin River

- Specific conductivity generally ranges between 14.9µS/cm to 21.2µS/cm during the deployment period, averaging 16.7µS/cm (Figure 4).
- Specific conductivity increases sharply from ~15µS/cm to ~17µS/cm on May 25 for a period of 16 hours. From May 25 to June 8, specific conductivity is increasing gradually and corresponds with a gradual decrease in water level. There is another sharp increase in specific conductivity from ~17µS/cm to ~19µS/cm on June 4 for a period of 12 hours.
- Stage is included in Figure 4 to illustrate the inverse relationship between conductivity and water level. Stage is decreasing throughout most of the deployment period. Generally, as stage levels decrease, specific conductivity generally increases due to the increasing concentration of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted. This trend is visible in the data collected during the deployment period and is indicated by red arrows in Figure 4.

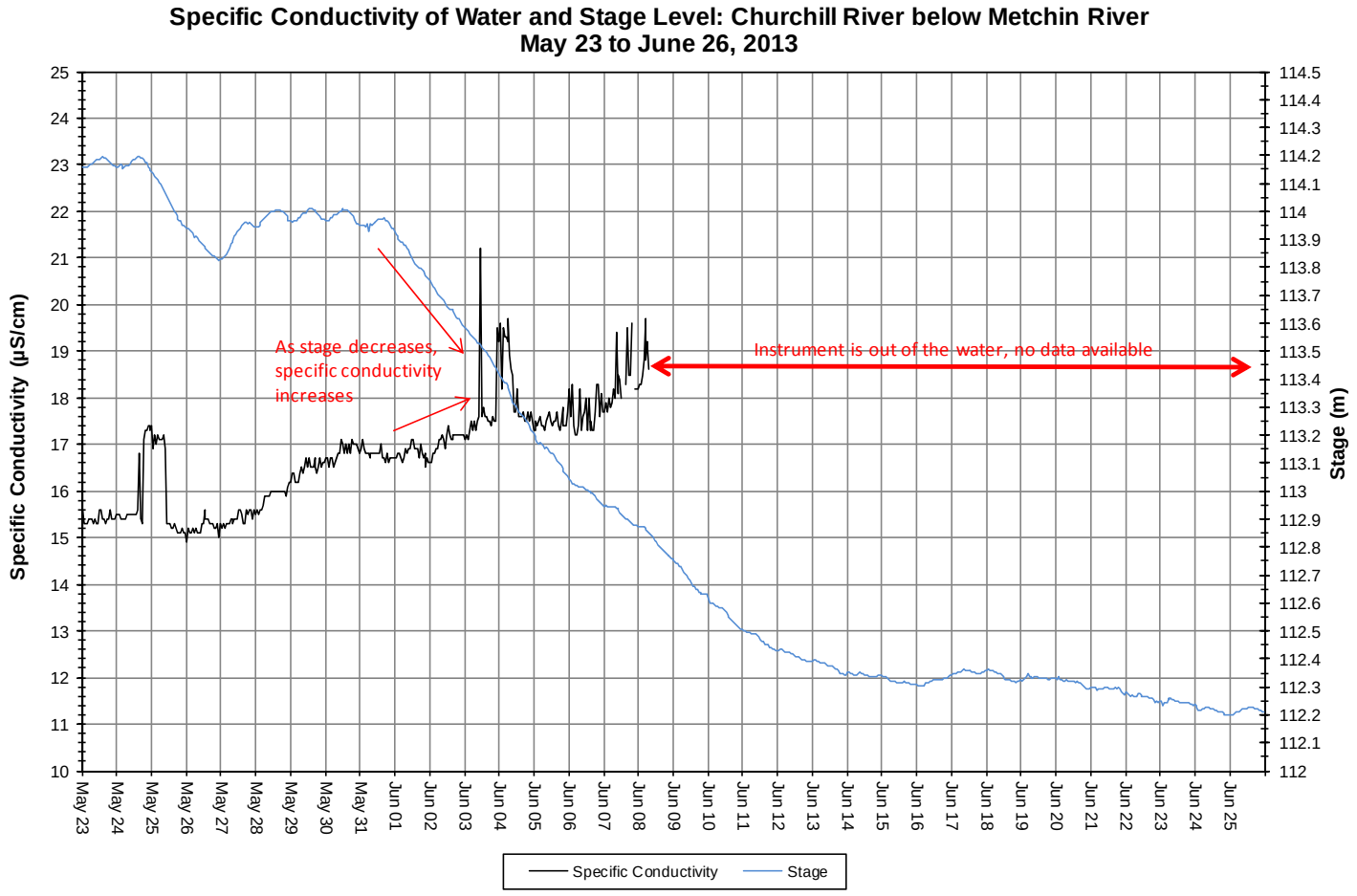


Figure 4: Specific conductivity and stage level at Churchill River below Metchin River

- Dissolved oxygen content ranges between 11.54mg/l and 12.80mg/l. The saturation of dissolved oxygen ranges from 91.4% to 100.8% (Figure 5).
- All values were above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5mg/l and Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content is decreasing throughout the deployment period. This trend is expected given the warming air and water temperatures (Figure 2).

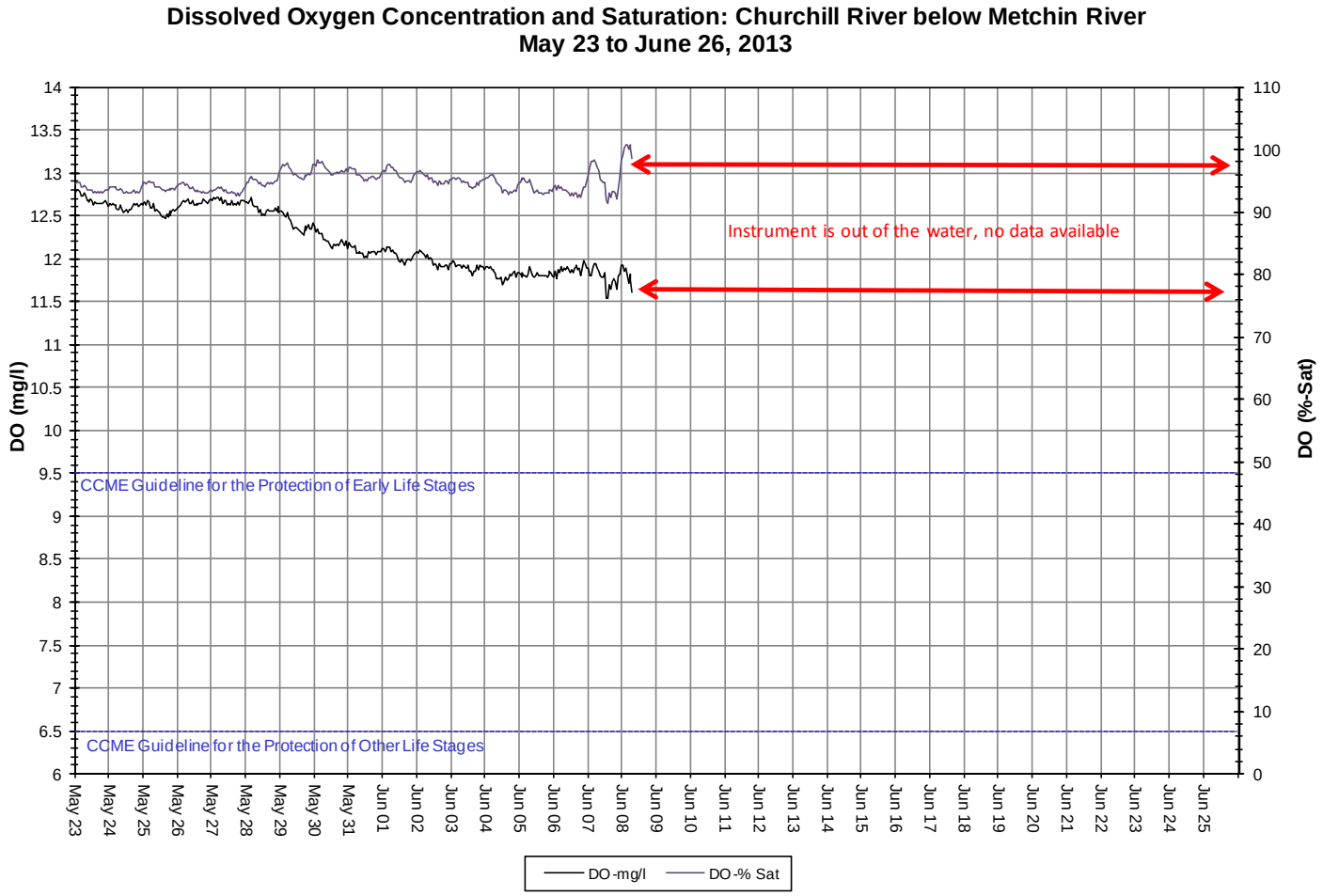


Figure 5: Dissolved oxygen and percent saturation at Churchill River below Metchin River

- Turbidity generally remains at 0NTU for the majority of the deployment period (Figure 6). A median value of 0NTU indicates there is no natural background turbidity value at this station.
- There are several instances when turbidity increases above 0NTU. These turbidity increase are relatively short-lived (1-2 hours) and low in magnitude (<30NTU). One event from June 4 to 5, lasts 24 hours and reaches a turbidity value of 55NTU. This turbidity even corresponds with the sharp increase in specific conductivity (Figure 4). Turbidity increases at this station on May 25 and June 4-5 correspond with precipitation events. These events are indicated in red on Figure 6.

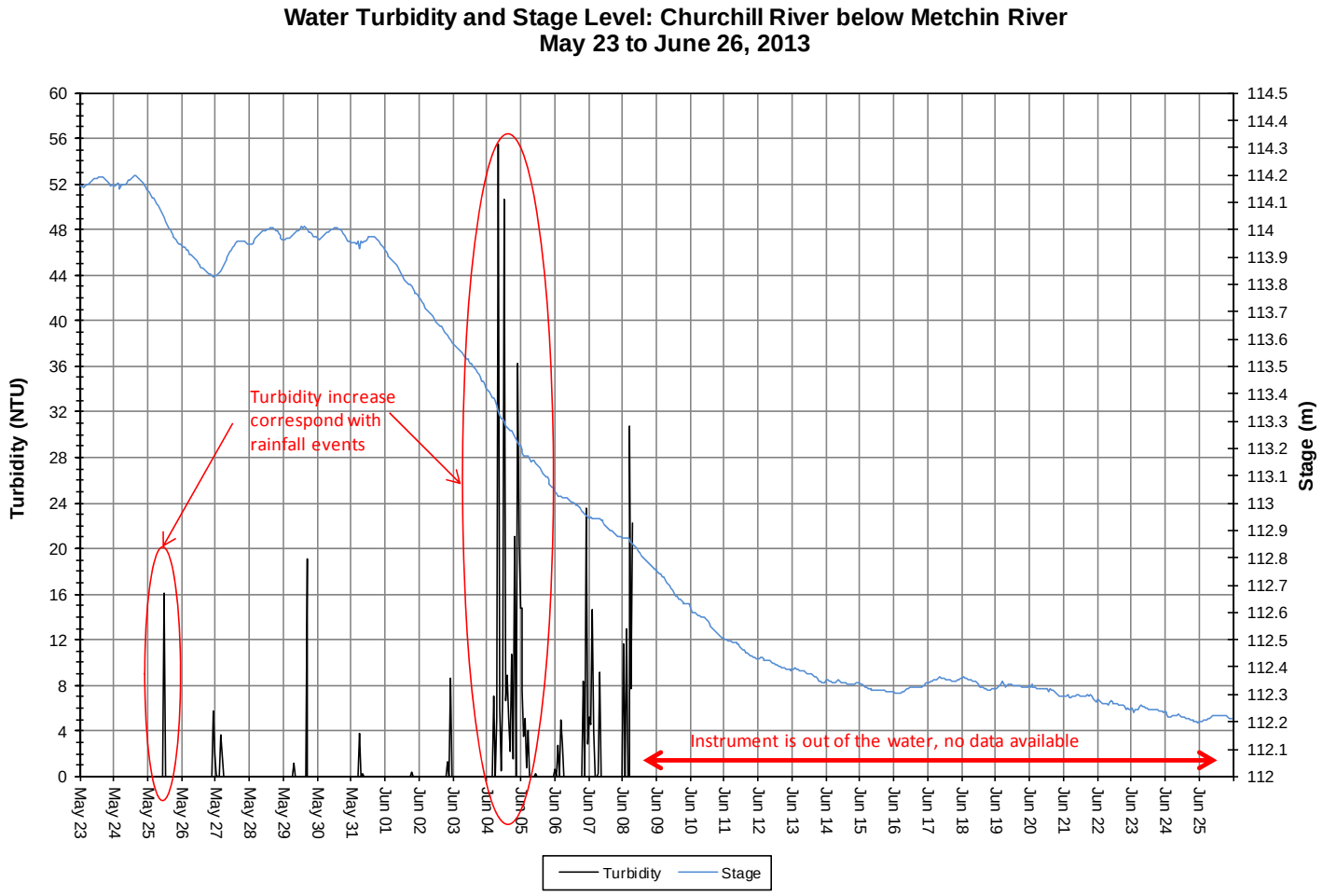


Figure 6: Turbidity and stage level at Churchill River below Metchin River

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 7). Stage is decreasing consistently throughout the deployment period. Precipitation records are frequent but low in magnitude and do not contribute significantly to the decreasing water level. Stage ranges between 112.20m and 114.20m, a difference of 2.00m.

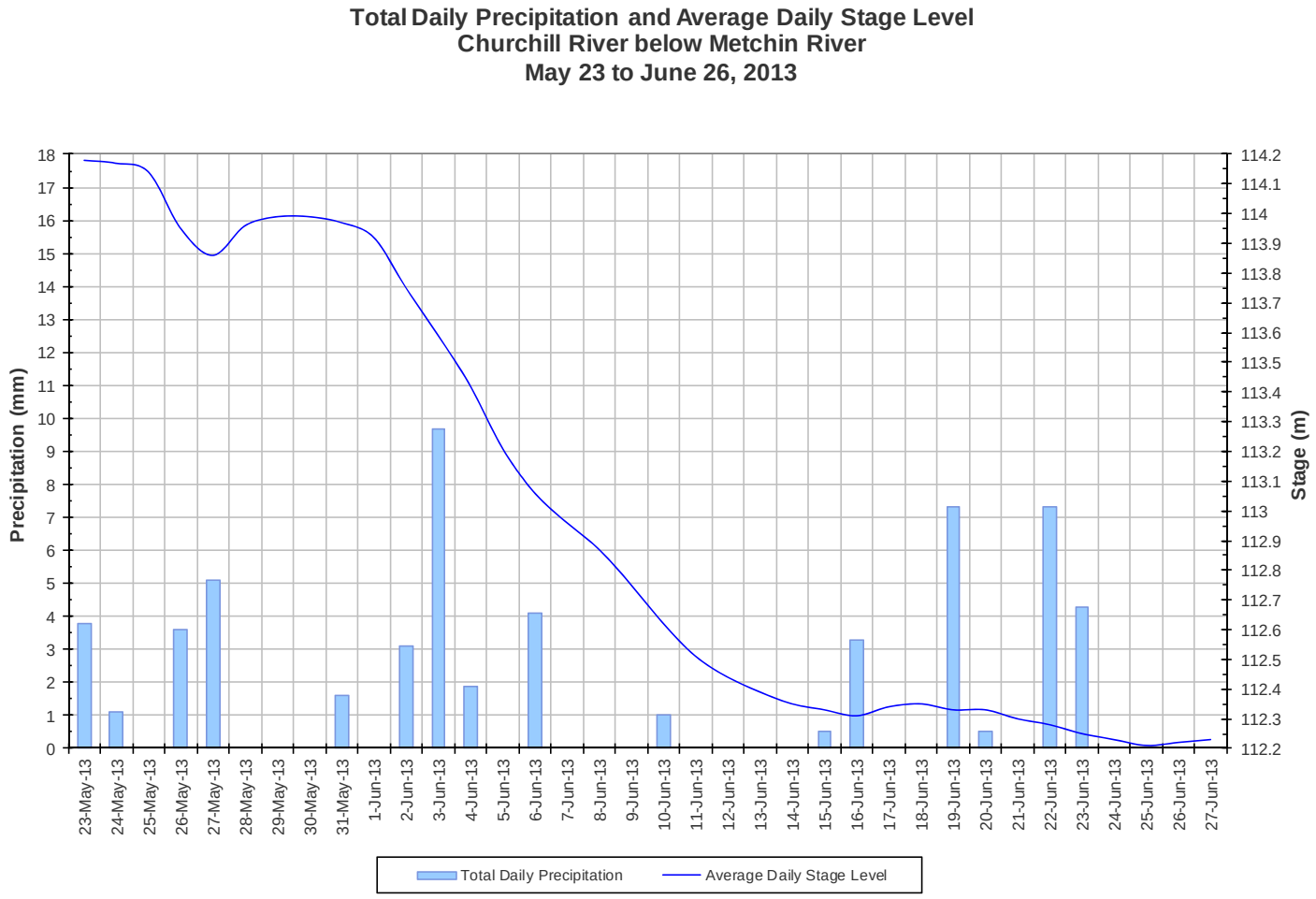


Figure 7: Daily precipitation and average daily stage level at Churchill River below Metchin River (weather data recorded at Churchill Falls)

Churchill River below Grizzle Rapids

- The water level at this station dropped considerably from the time of deployment until the time the instrument was retrieved. The instrument was never fully exposed to air during the deployment period. However, when the instrument was retrieved, it was in very shallow water near the shoreline. Due to the drop in water level, the water quality data may reflect diurnal changes more greatly in the second half of the deployment period when the water levels were low.

- Water temperature ranges from 2.20°C to 14.10°C during the deployment period (Figure 8).
- Water temperature is increasing throughout the deployment period. This trend is expected due to the warming ambient air temperatures in the spring season (Figure 9). Water temperature fluctuates diurnally, especially near the end of the deployment period, changing up to 4°C from day to night.

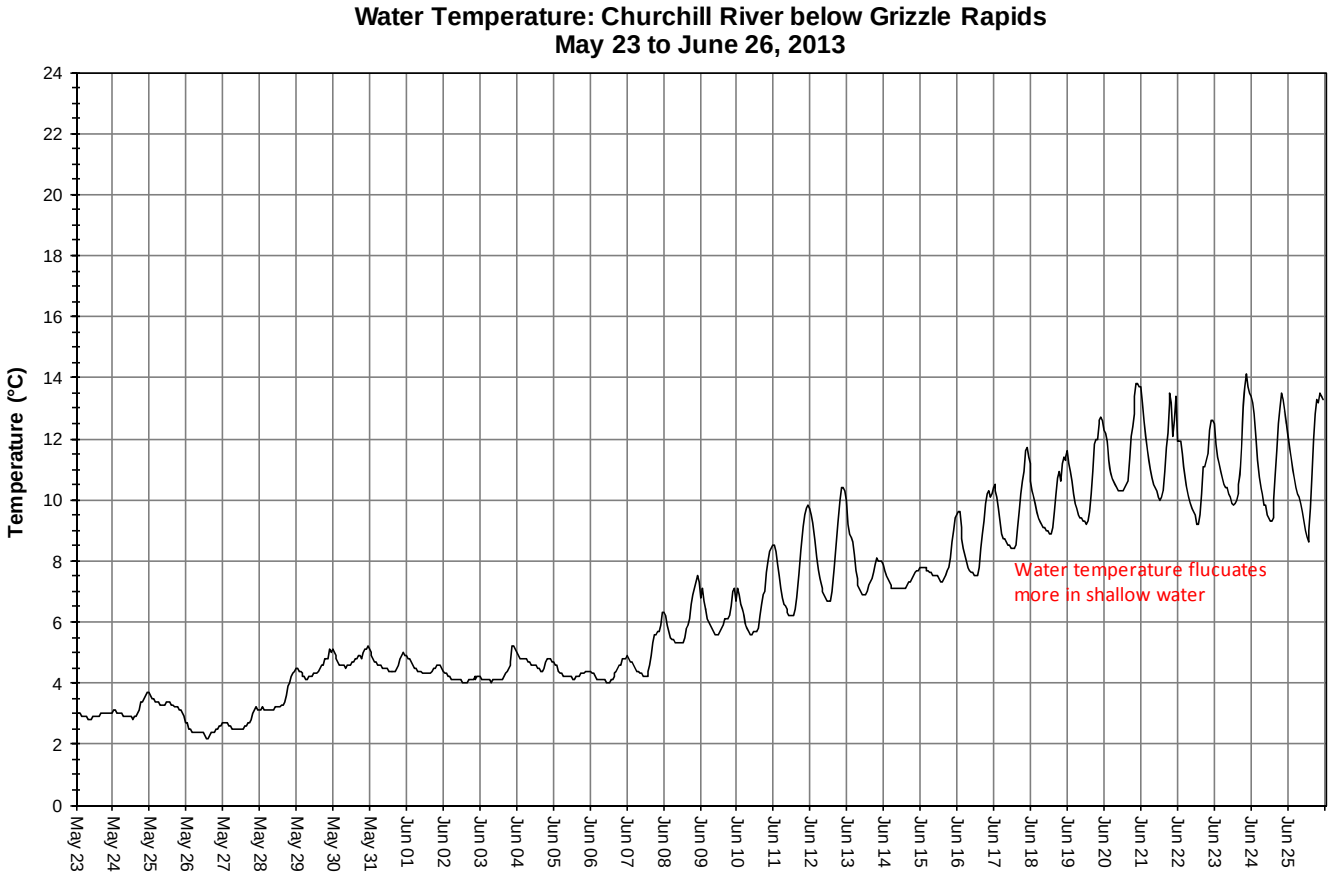


Figure 8: Water temperature at Churchill River below Grizzle Rapids

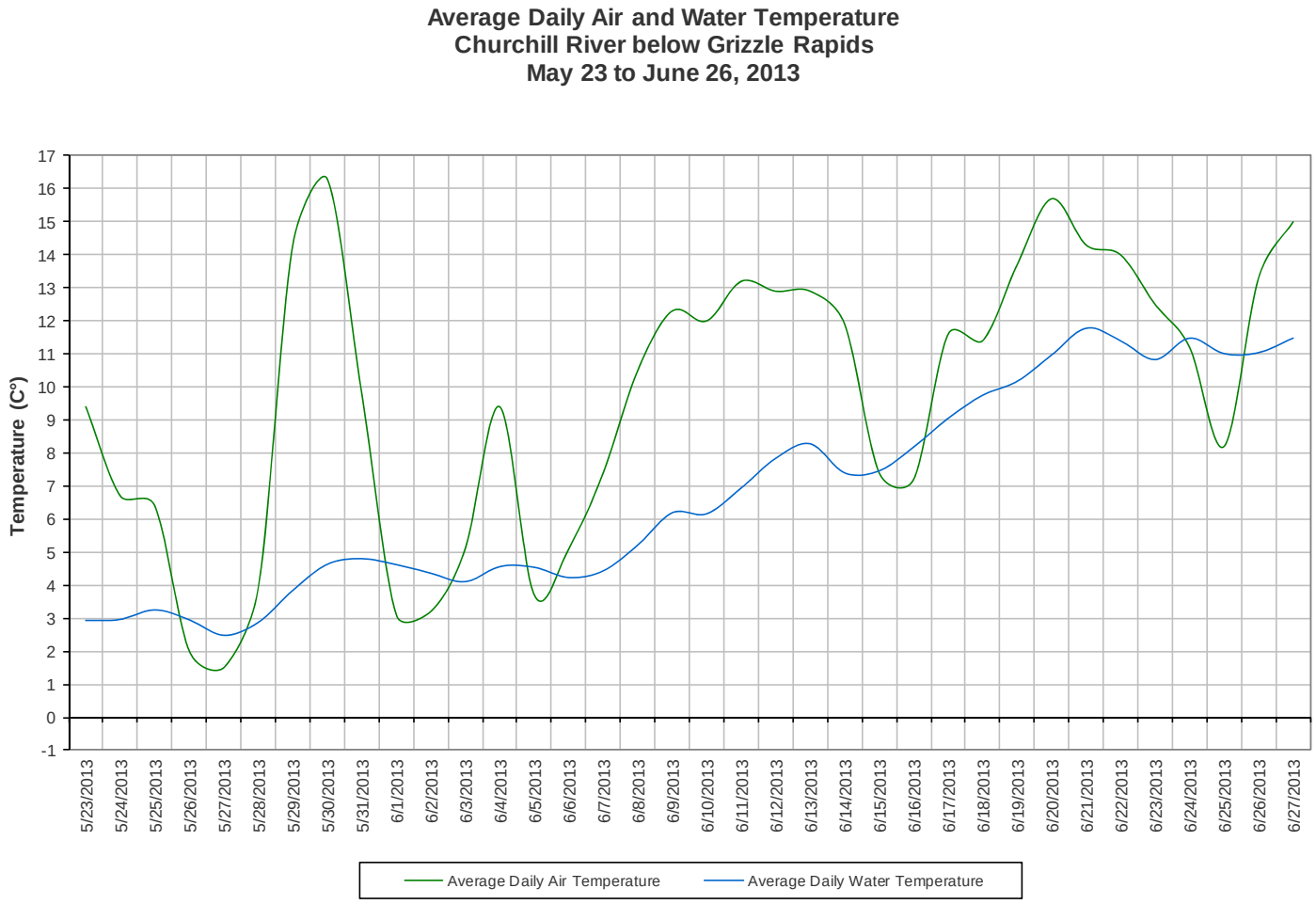


Figure 9: Average daily air and water temperature at Churchill River below Grizzle Rapids

(weather data recorded at Goose Bay)

- pH ranges between 6.72 and 7.10 pH units (Figure 10).
- pH values are very stable for the first half of the deployment period when the instrument is in deeper water. After the water level drops, pH values fluctuate regularly on a daily basis for the remainder of the deployment period.
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 10).

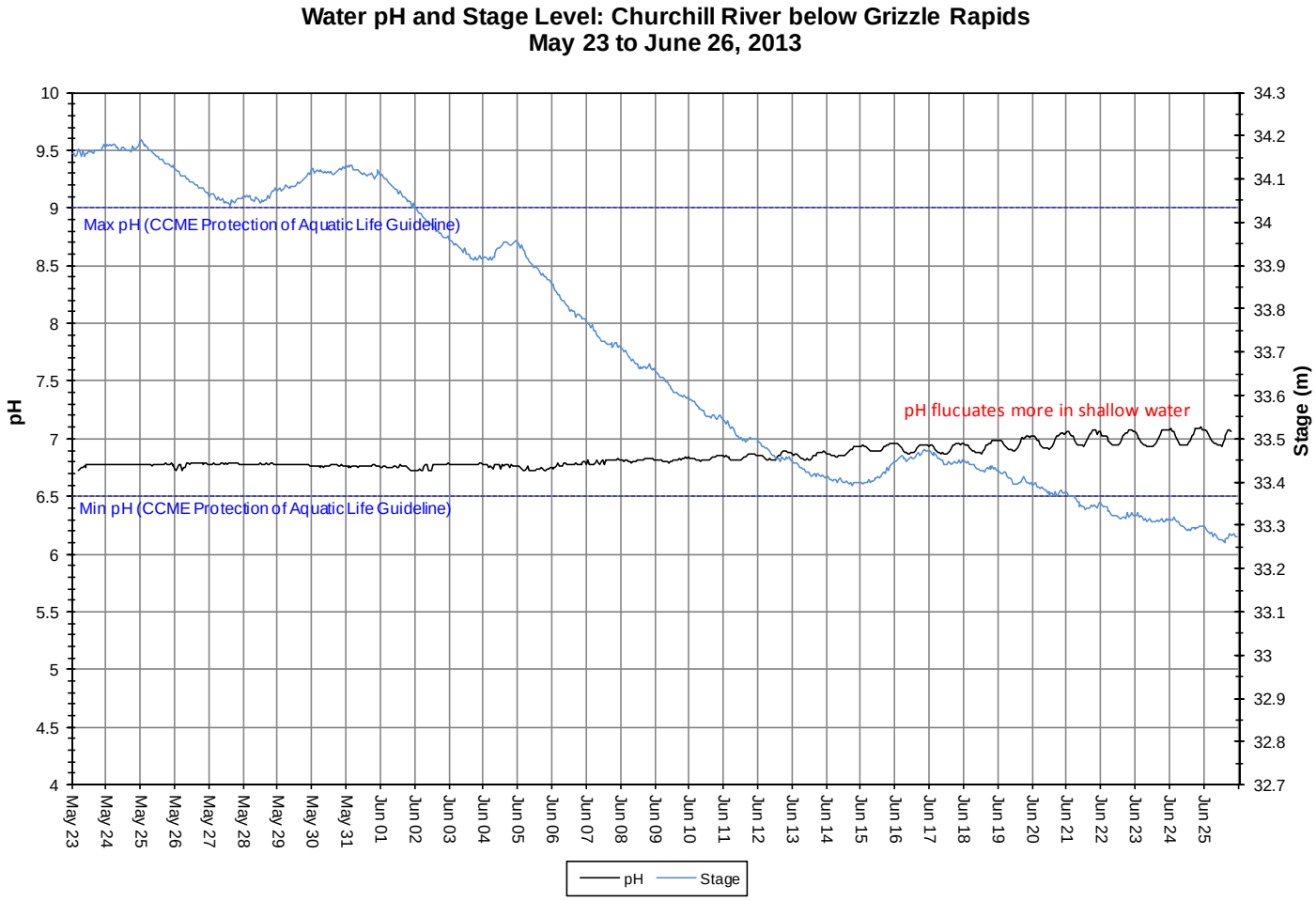


Figure 10: pH and stage level at Churchill River below Grizzle Rapids

- Specific conductivity ranges from 13.7 to 17.2µS/cm during the deployment period, averaging 14.9µS/cm (Figure 11).
- Specific conductance is increasing slightly throughout the deployment period.
- Stage is included in Figure 11 to illustrate the inverse relationship between conductivity and water level. Typically, stage is decreasing throughout the deployment period with minimal fluctuations. Generally, as stage levels decrease, specific conductivity increases due to the increased concentration of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted.

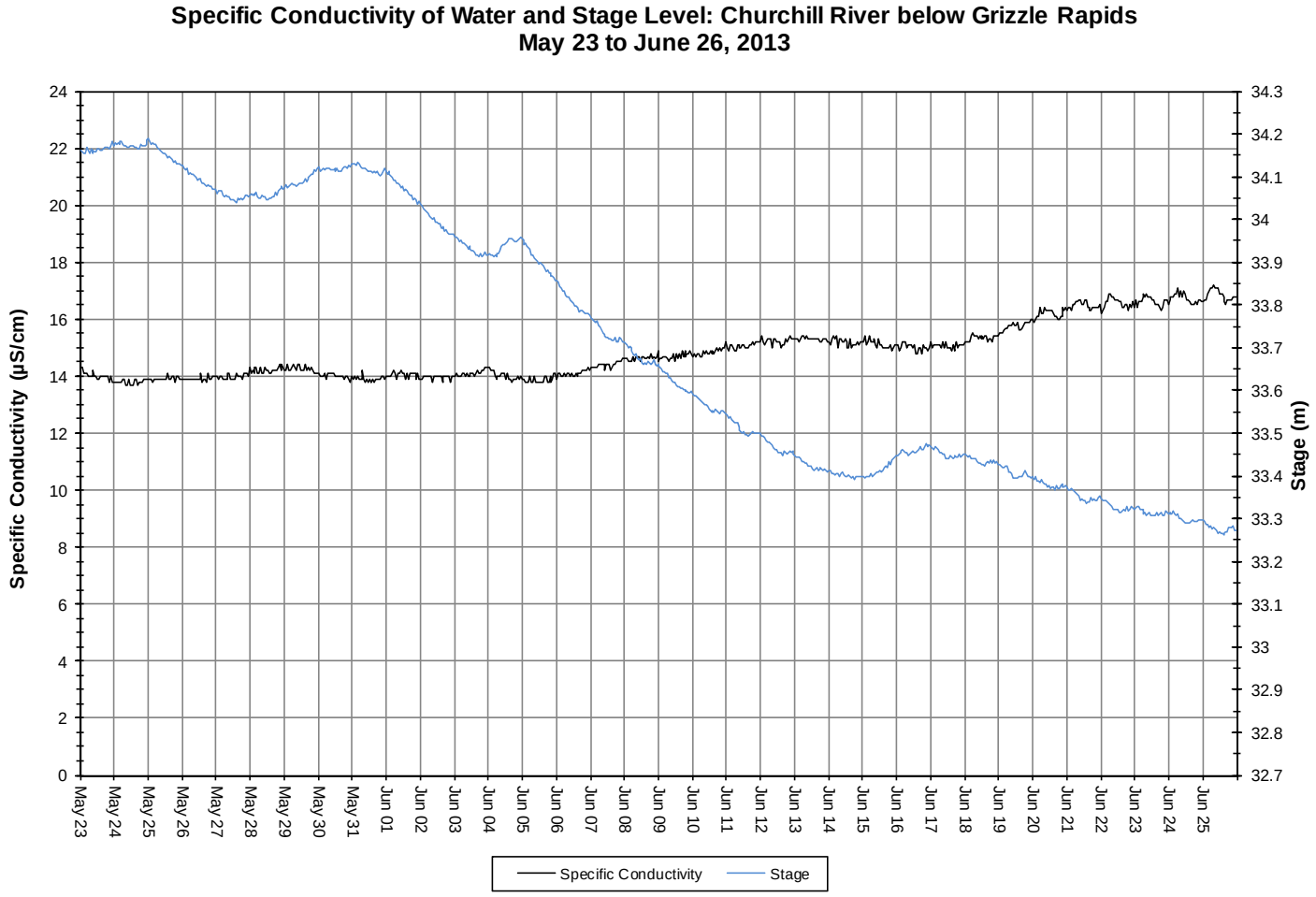


Figure 11: Specific conductivity and stage level at Churchill River below Grizzle Rapids

- Dissolved oxygen content ranges between 10.32mg/l and 12.95mg/l. The saturation of dissolved oxygen ranges from 92.3% to 102.00% (Figure 12).
- All values were above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5mg/l and Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 12.
- Dissolved oxygen content is decreasing throughout the deployment period. This trend is expected given the warming air and water temperatures (Figure 9). Dissolved oxygen content increases during the warm days and decreases during the cool nights. This trend is clearly noticeable in the second half of the deployment period when the instrument is in shallow water.

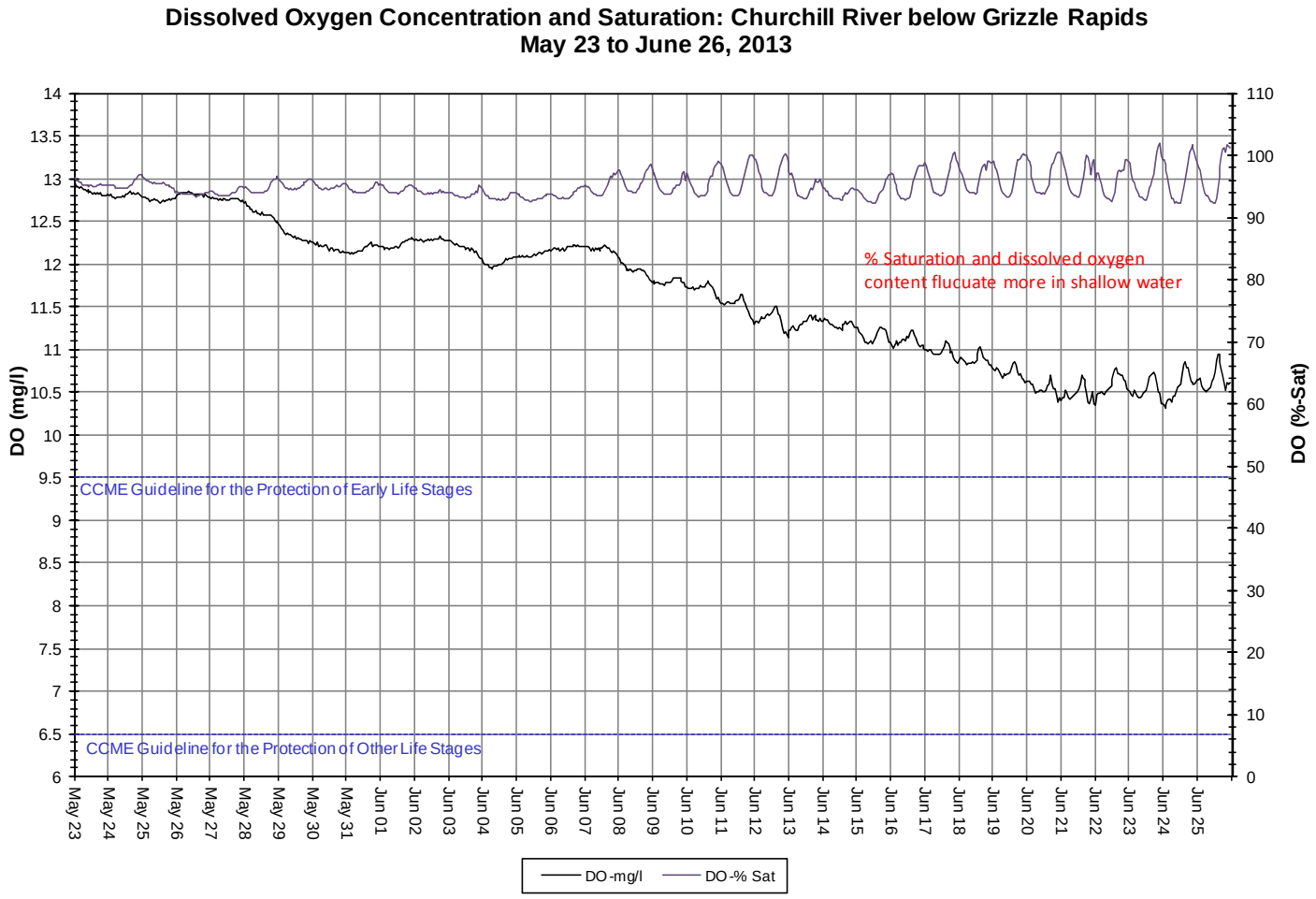


Figure 12: Dissolved oxygen and percent saturation at Churchill River below Grizzle Rapids

- Turbidity values generally remained at 0NTU for the majority of the deployment period (Figure 13). A median value of 0NTU at this station indicates there is no natural background turbidity.
- This trend is typical of this station as the river reach runs clearly and quickly though Grizzle Rapids. There are a couple of instances when turbidity values are recorded as high as 14.7NTU. These increases are short lived (1-4 hours) and not significant.

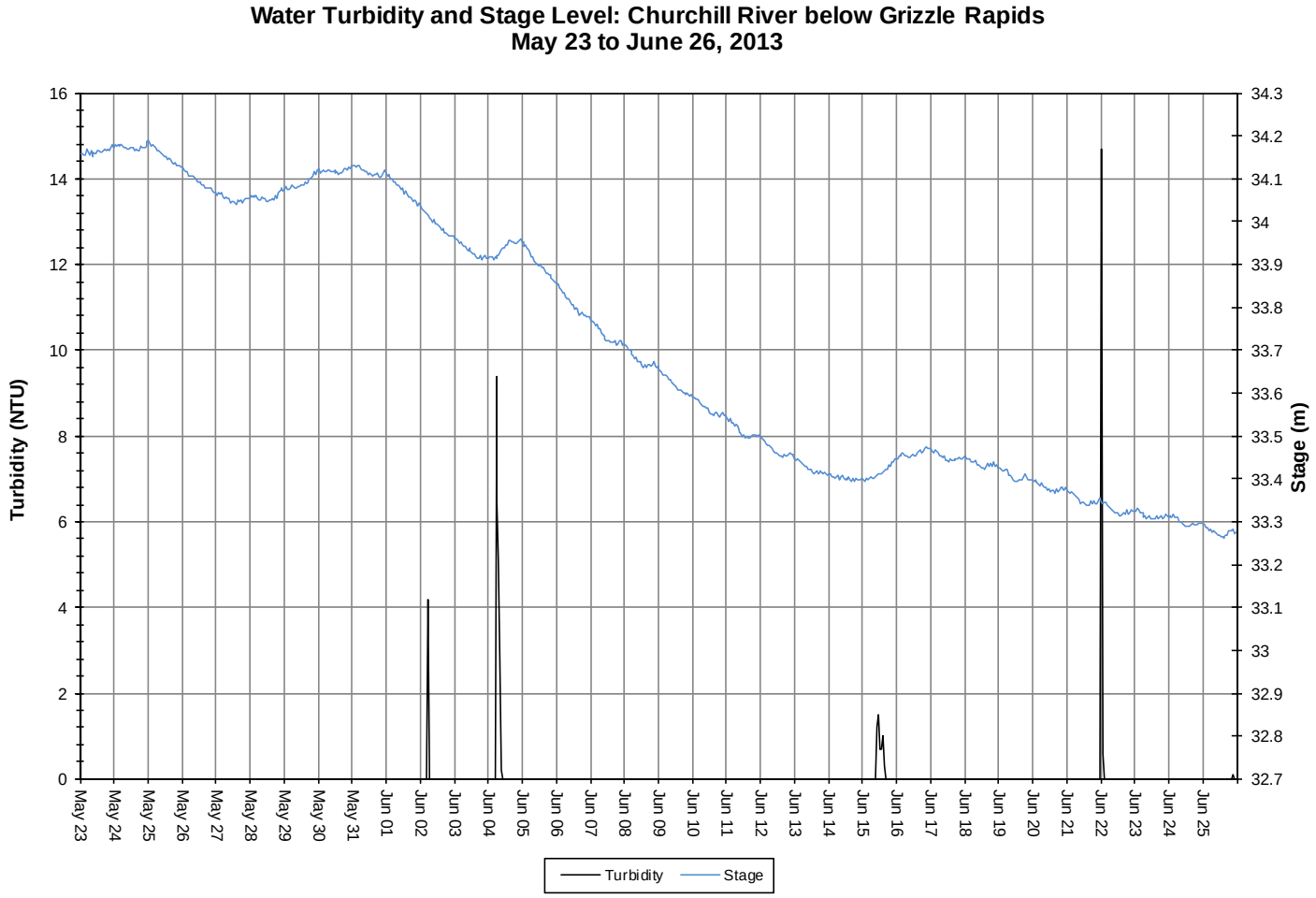


Figure 13: Turbidity and stage level at Churchill River below Grizzle Rapids

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 14). Stage is decreasing throughout the deployment period. Precipitation amounts are moderate in frequency and low in magnitude. Stage ranges between 33.26m and 34.19m, a difference of 0.93m.

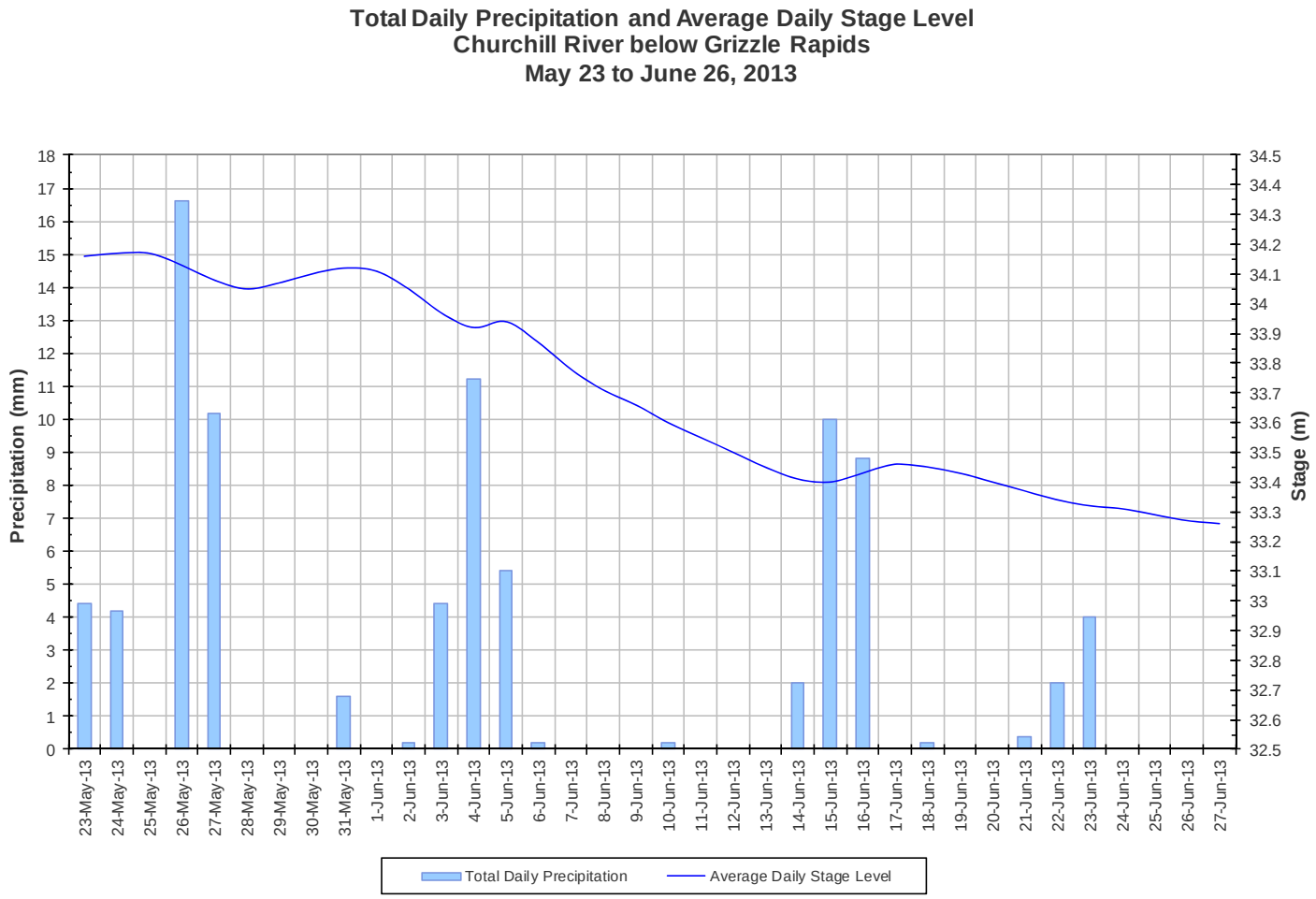


Figure 14: Daily precipitation and average daily stage level at Churchill River below Grizzle Rapids (weather data recorded at Goose Bay)

Churchill River above Muskrat Falls

- The instrument deployed at this station became exposed to air following a significant drop in the water level between May 23 and June 12. Data recorded after June 12 during the time the instrument was exposed, has been removed from the data set and is not included in the following graphs for the station.

- Water temperature ranges from 2.63°C to 9.99°C during the deployment period (Figure 15).
- Water temperature is increasing throughout the deployment period. This trend is expected given the warming ambient air temperatures in the spring season (Figure 16). Water temperature fluctuates diurnally.

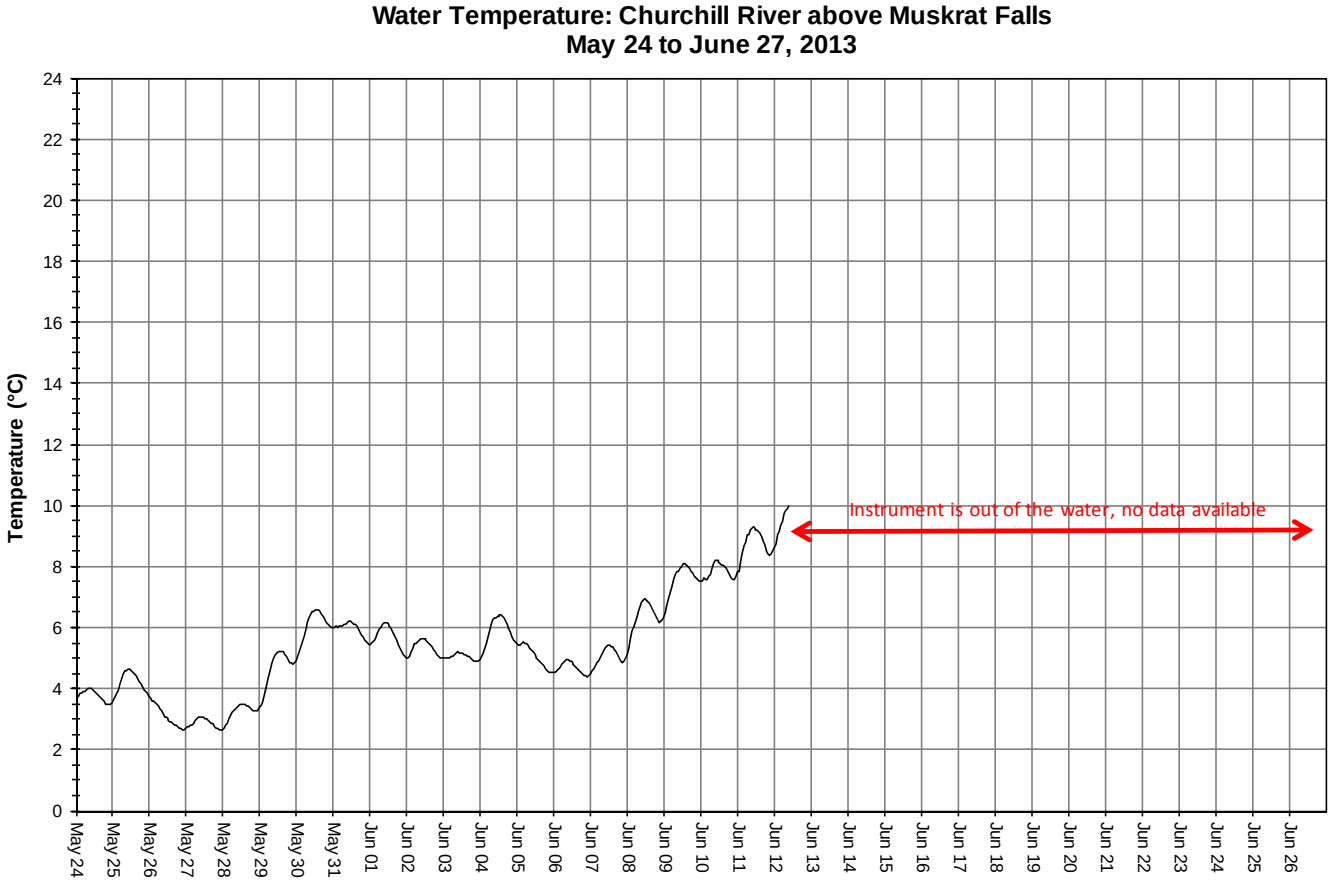


Figure 15: Water temperature at Churchill River above Muskrat Falls

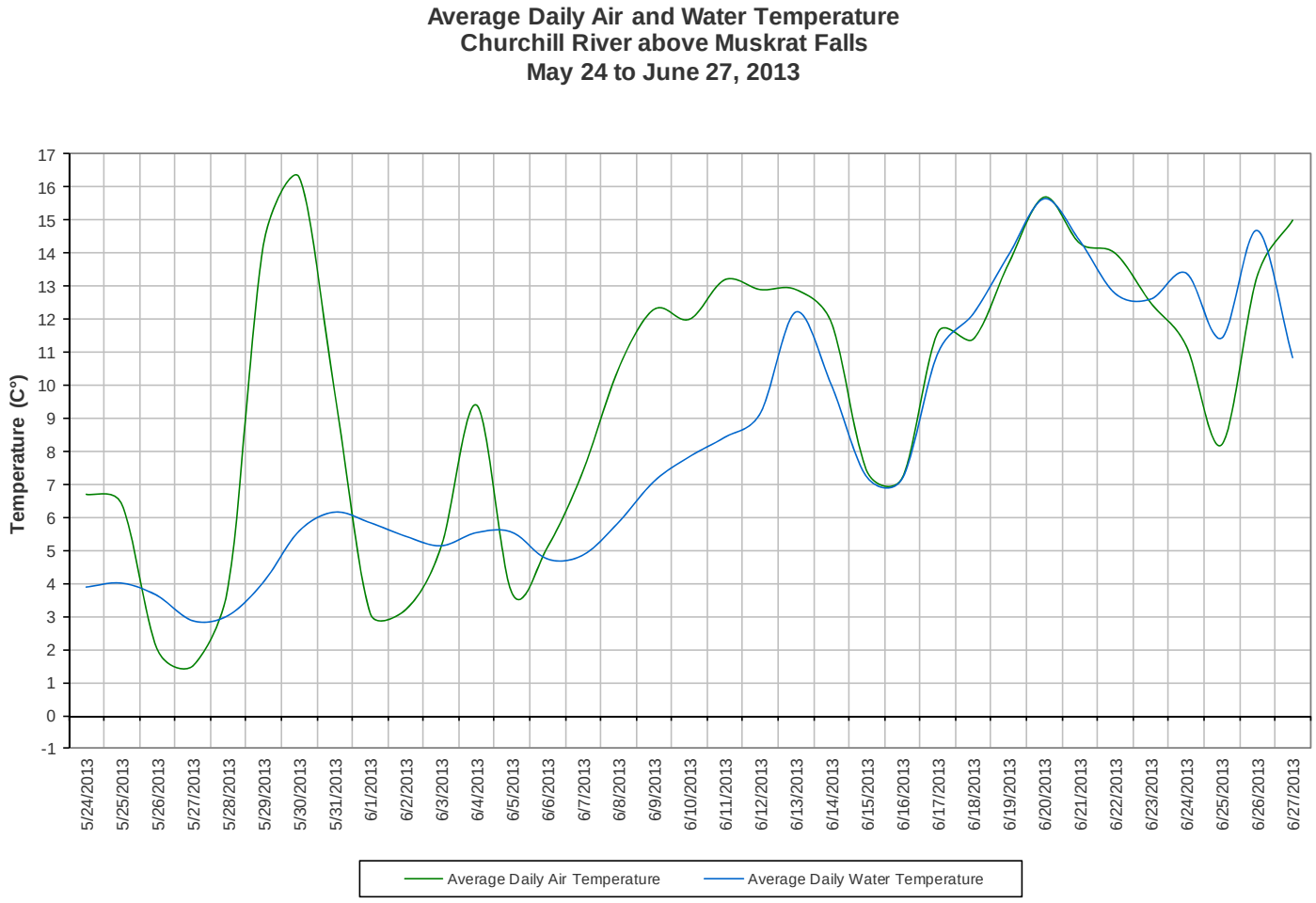


Figure 16: Average daily air and water temperature at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

- pH ranges between 6.48 and 6.60 pH units (Figure 17). pH values are stable throughout the deployment period.
- All pH values recorded are very close to the lower recommended value for pH as suggested by the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 17).

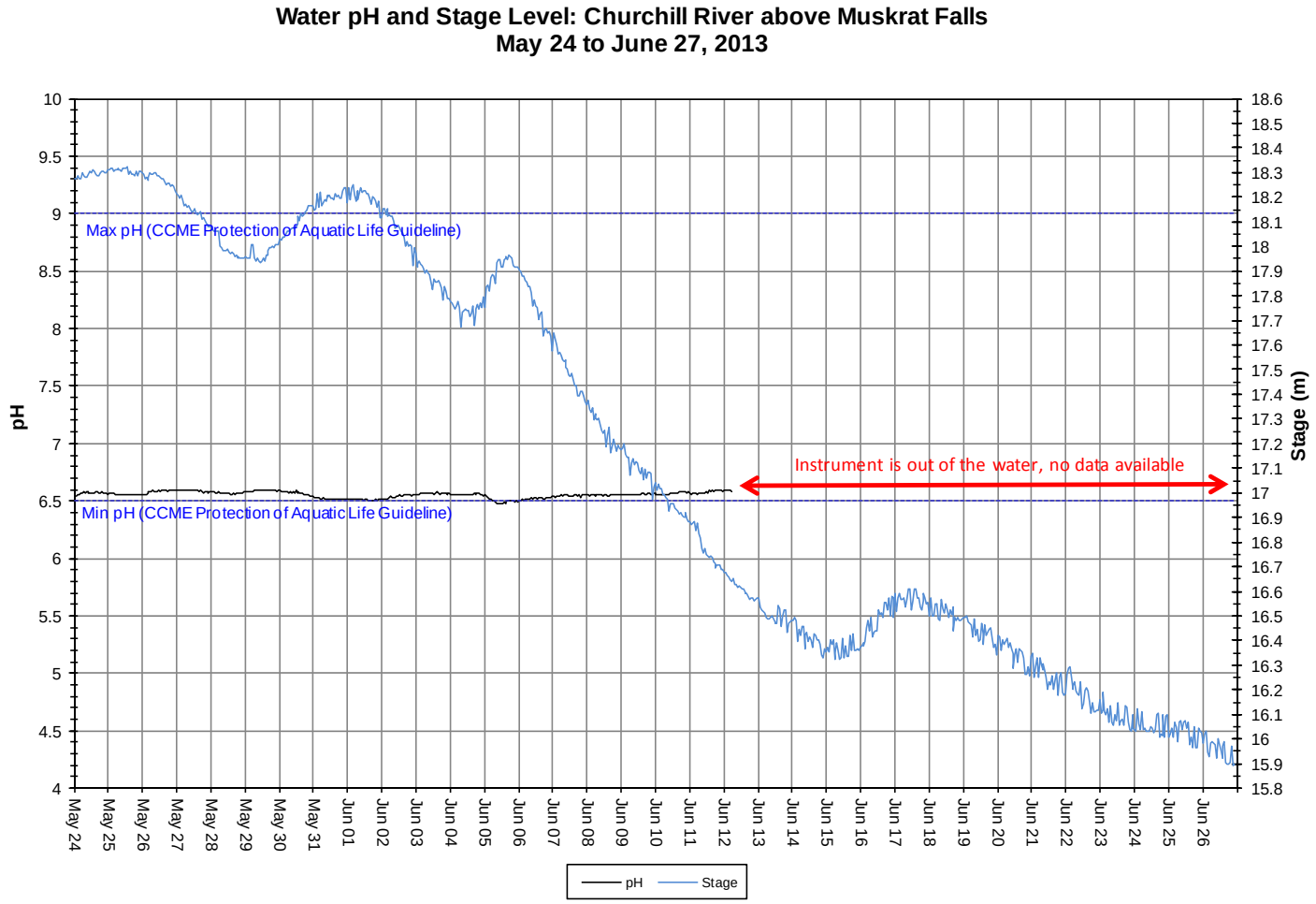


Figure 17: pH and stage at Churchill River above Muskrat Falls

- Specific conductivity ranges from 10.7µS/cm to 15.5µS/cm during the deployment period, averaging 12.1µS/cm. (Figure 18).
- Specific conductance increases and decreases throughout the first half of the deployment period. The specific conductance is on average the lowest at this station when compared across the network.
- Stage is included in Figure 18 to illustrate the inverse relationship between conductivity and water level. Stage is generally decreasing throughout the deployment period. Generally, as stage levels decrease, specific conductivity generally increases due to the increasing concentration of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted. This trend is indicated by red arrows on Figure 18.

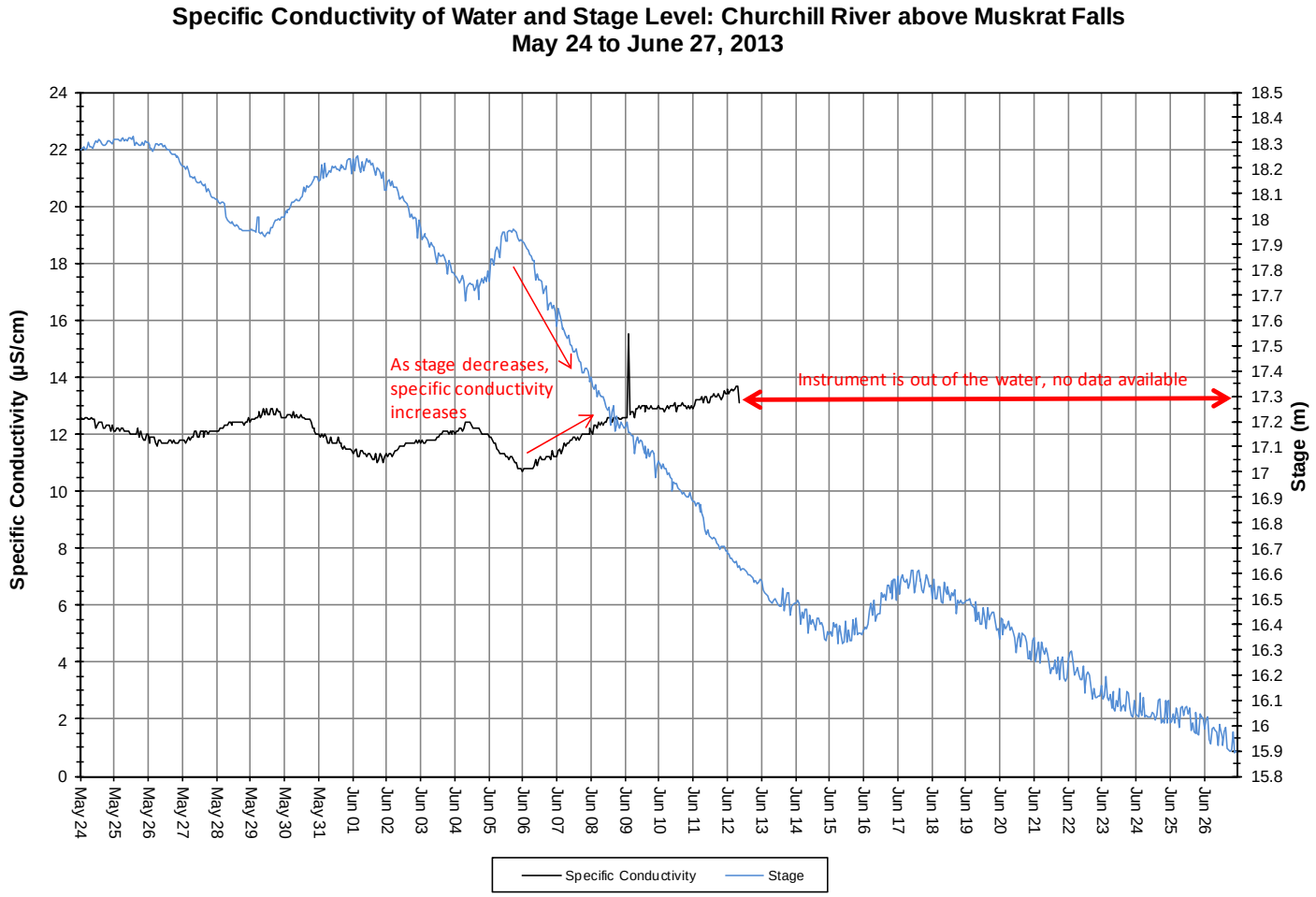


Figure 18: Specific conductivity and stage level at Churchill River above Muskrat Falls

- Dissolved oxygen content ranges between 11.42mg/l and 13.16mg/l. The saturation of dissolved oxygen ranges from 95.6% to 102.3% (Figure 19).
- All values were above both the minimum CCME Guideline for the Protection of Cold Water Biota at Other Life Stages of 6.5mg/l and Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 19.
- Dissolved oxygen content is decreasing throughout the deployment period. This trend is expected given the warming air and water temperatures (Figure 16).

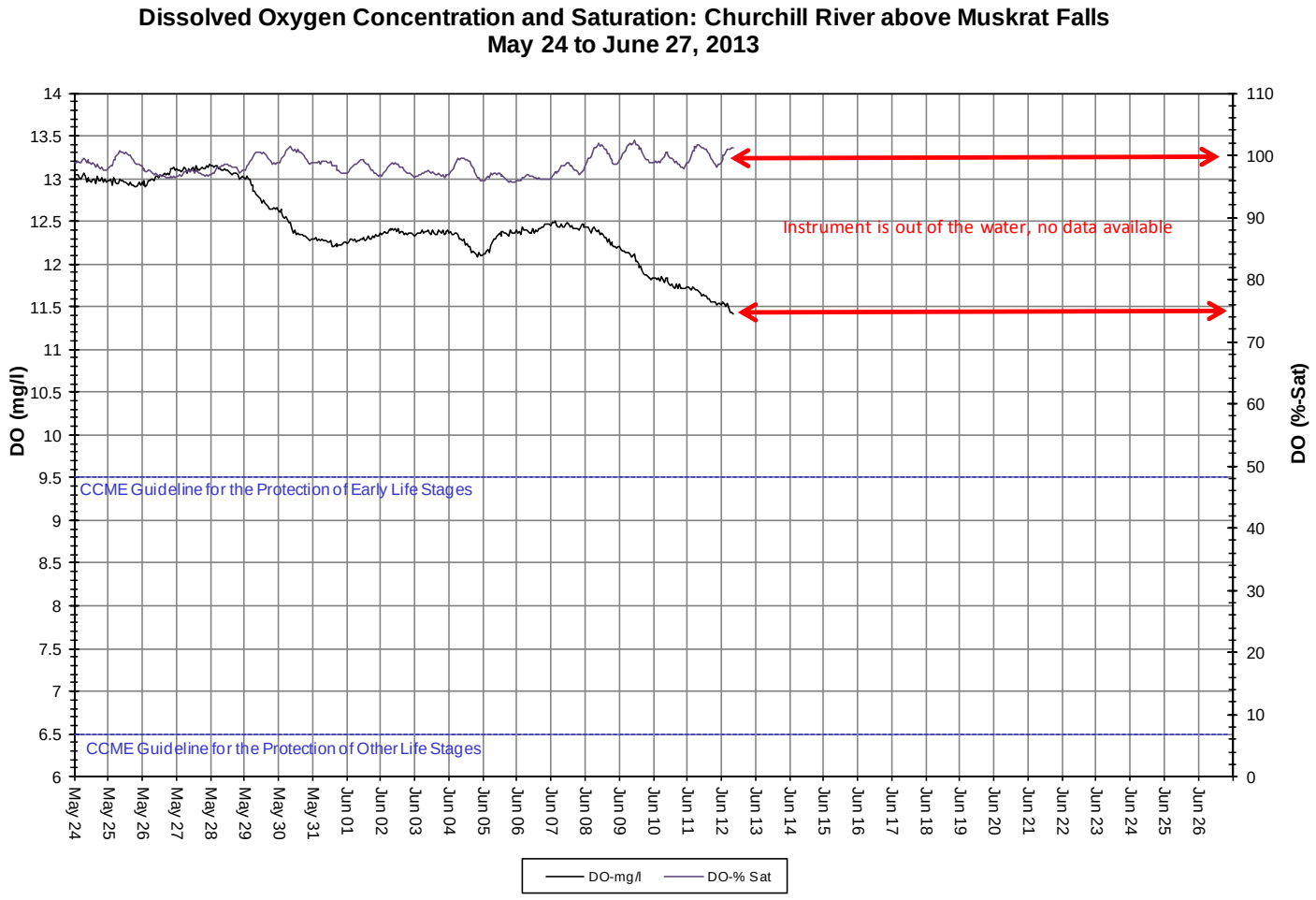


Figure 19: Dissolved oxygen and percent saturation at Churchill River above Muskrat Falls

- Turbidity generally ranges between 3NTU and 53NTU, averaging 12NTU (Figure 20). A median value of 9.3NTU indicates there is a consistent natural background turbidity value. This trend is typical at this station.
- There are several increases in turbidity throughout the deployment period. Rainfall events recorded in the area on May 26-27 totaling 26mm may have in part caused a turbidity increase from May 26-28. Similarly, rainfall amounts totaling 20mm on June 2-6 may have caused an increase in turbidity from June 5- 7. There is no corresponding rainfall event for the increase in turbidity experienced between May 29 and June 2. Just before the instrument was exposed to air on June 12, there is an increase in turbidity; this is likely due to the increase in wave action at the shoreline prior to the instrument becoming exposed to air. These events are indicated in red on Figure 20.

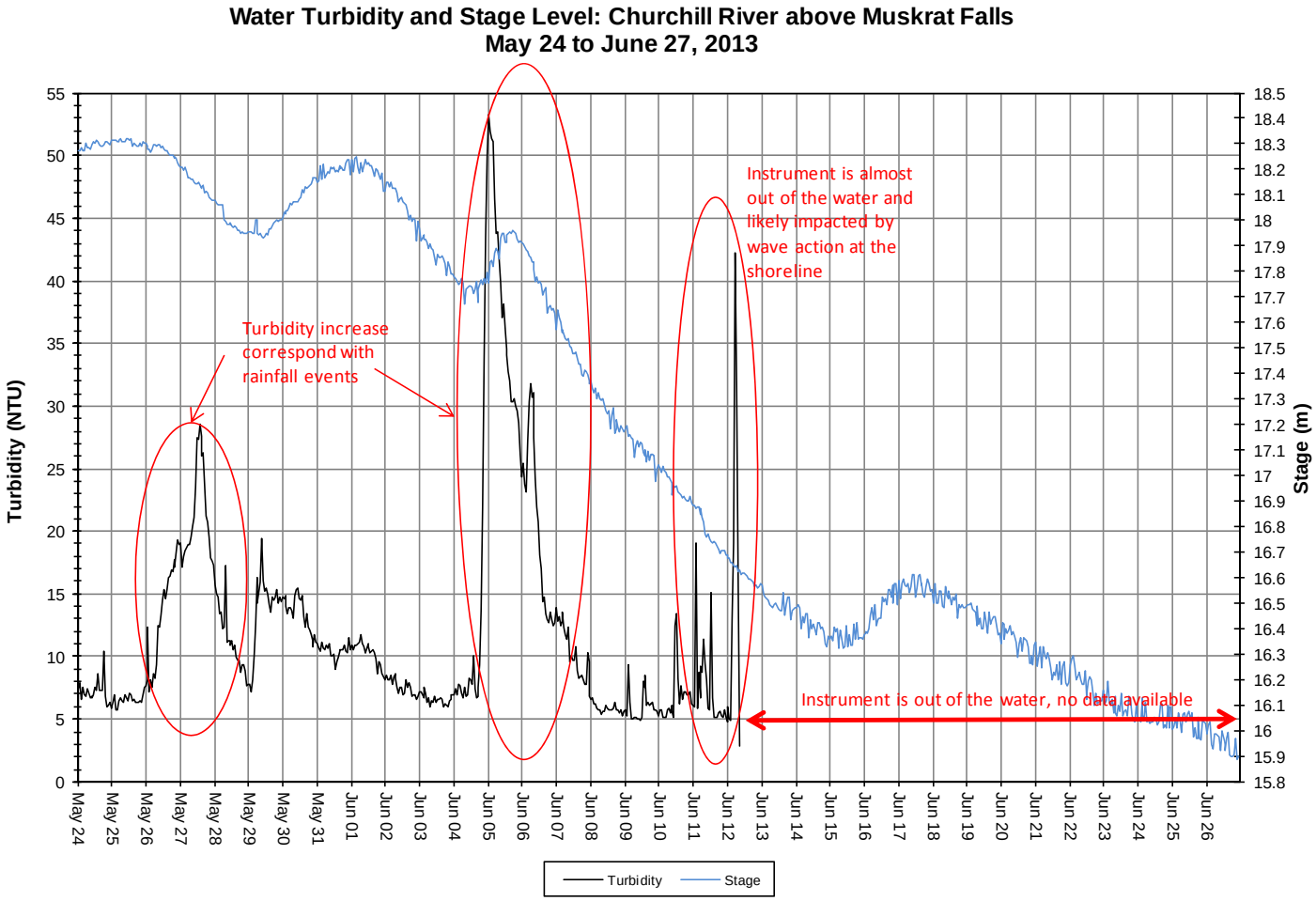


Figure 20: Turbidity and stage level at Churchill River above Muskrat Falls

- Chlorophyll is now being measured at the station above Muskrat Falls (Figure 21). The sensor is undergoing testing and is currently not functioning. The sensor may require additional calibration by an instrument technician. The values collected for the deployment period are inaccurate and have been removed from the data set.

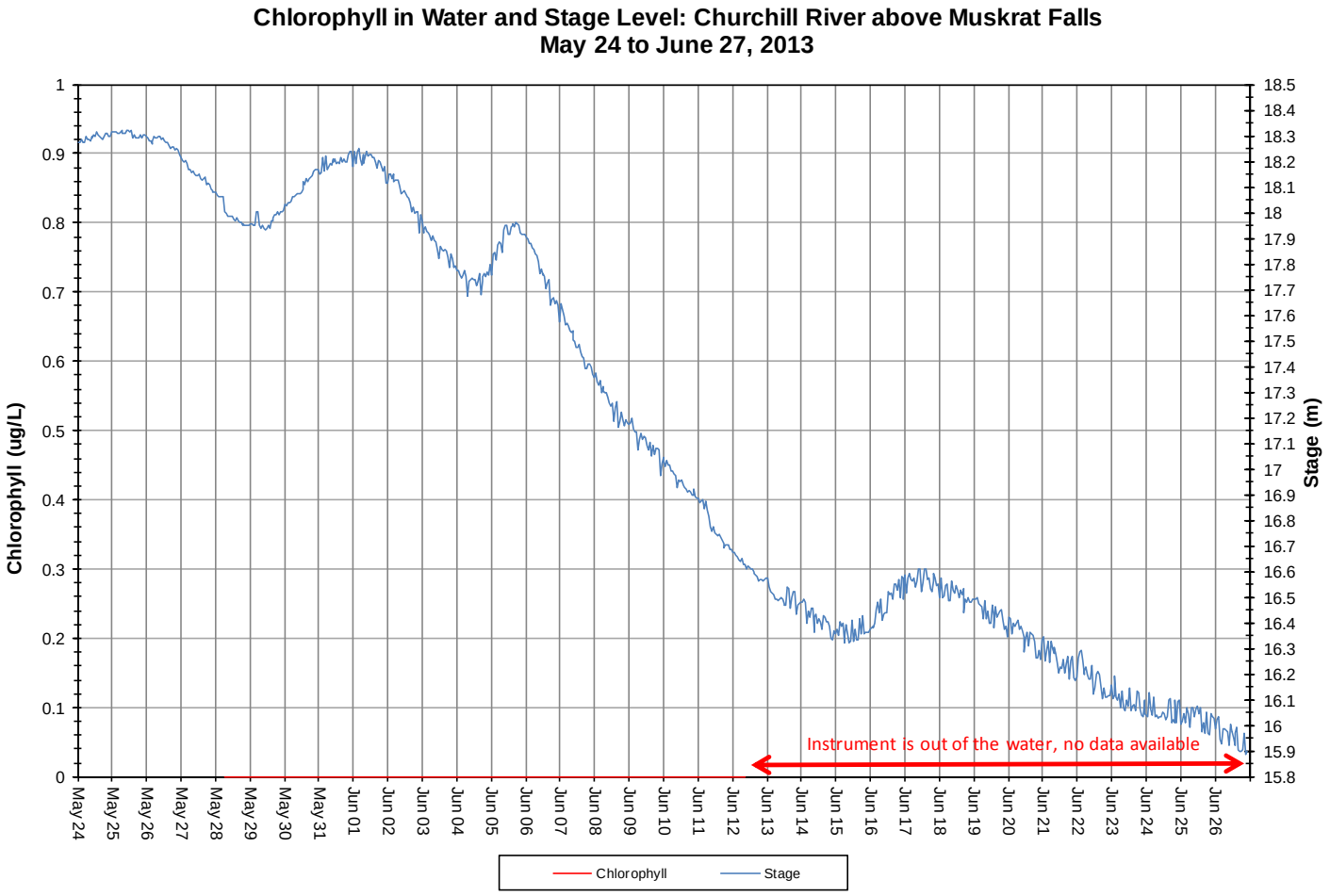


Figure 21: Chlorophyll and stage level at Churchill River above Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 22). Stage is decreasing throughout the deployment period. Precipitation records are generally low in magnitude and moderate in frequency. Stage ranges between 15.98m and 18.32m, a difference of 2.34m. Discharge ranges from 1220 m^3/s to 2800m^3/s.

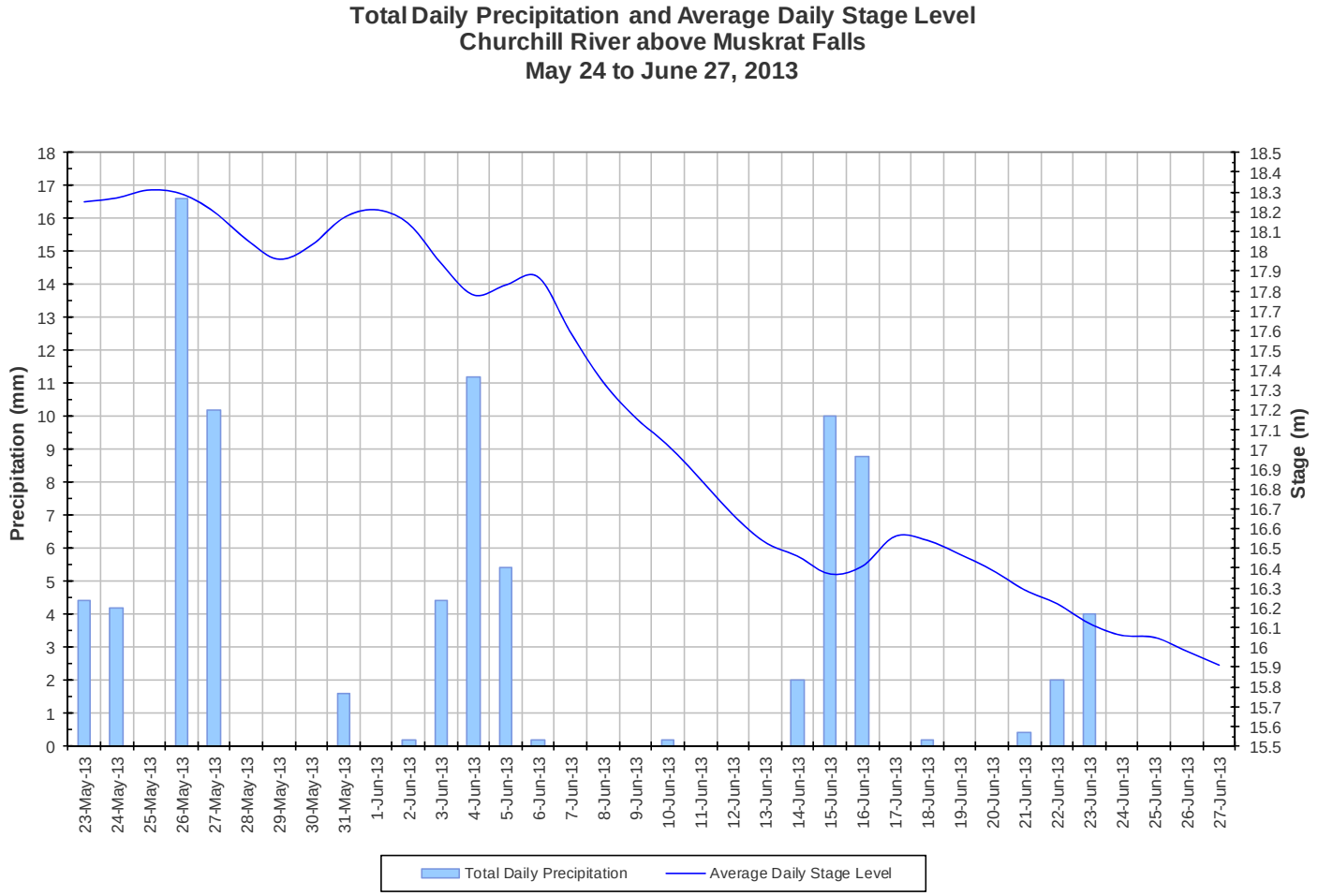


Figure 22: Daily precipitation and average daily stage level at Churchill River above Muskrat Falls (weather data recorded at Goose Bay)

Churchill River below Muskrat Falls

- The instrument deployed at this station became exposed to air following a significant drop in the water level between May 23 and June 19. Data recorded after June 19 during the time the instrument was exposed, has been removed from the data set and is not included in the following graphs for the station.

- Water temperature ranges from 1.90°C to 10.30°C during the deployment period (Figure 23).
- Water temperature is increasing throughout the deployment period. This trend is expected given the warming ambient air temperatures in the spring season (Figure 24). Water temperature fluctuates diurnally, especially in the week preceding the instruments exposure to air. The water would have been shallow and more susceptible to changes in temperature.

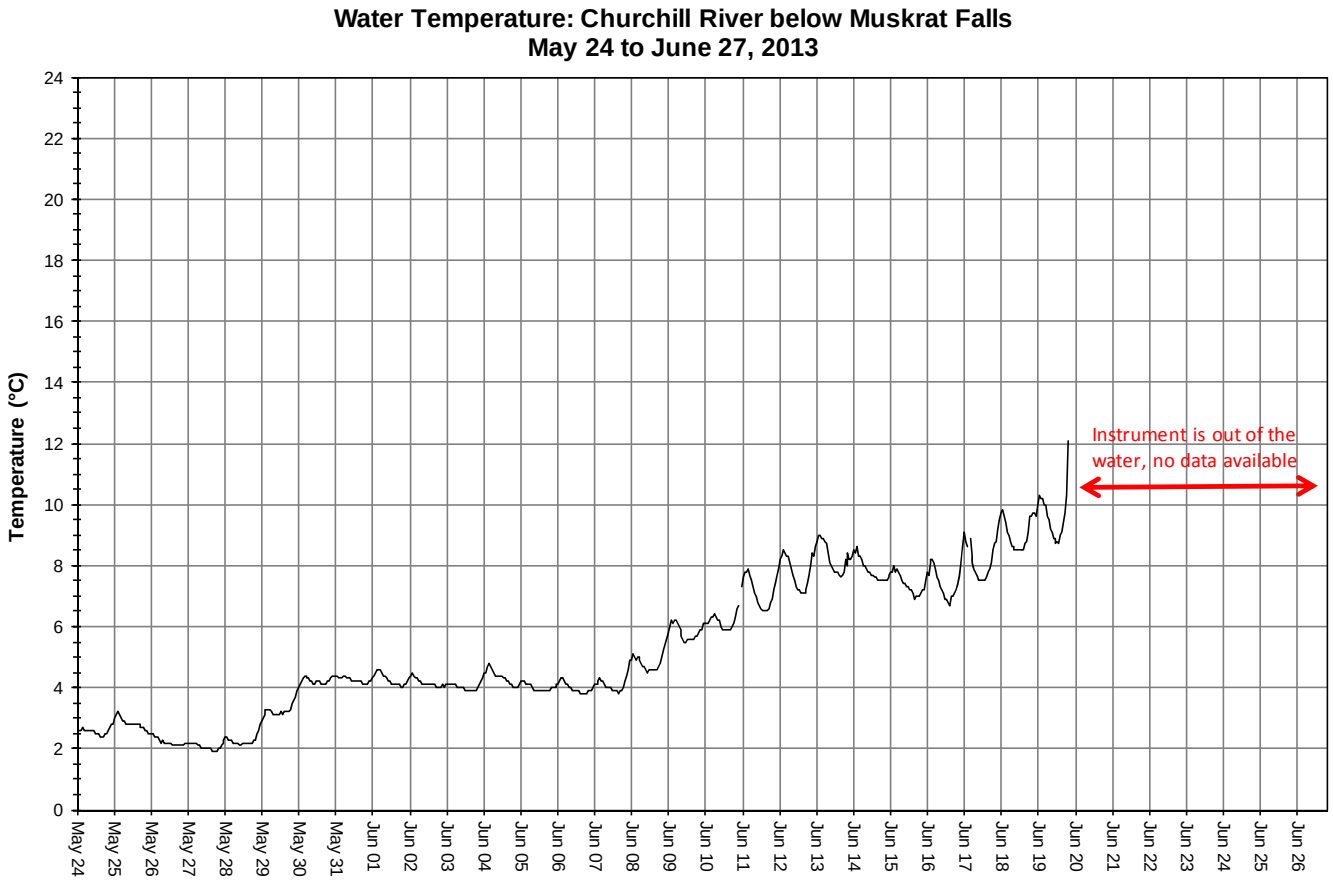


Figure 23: Water temperature at Churchill River below Muskrat Falls

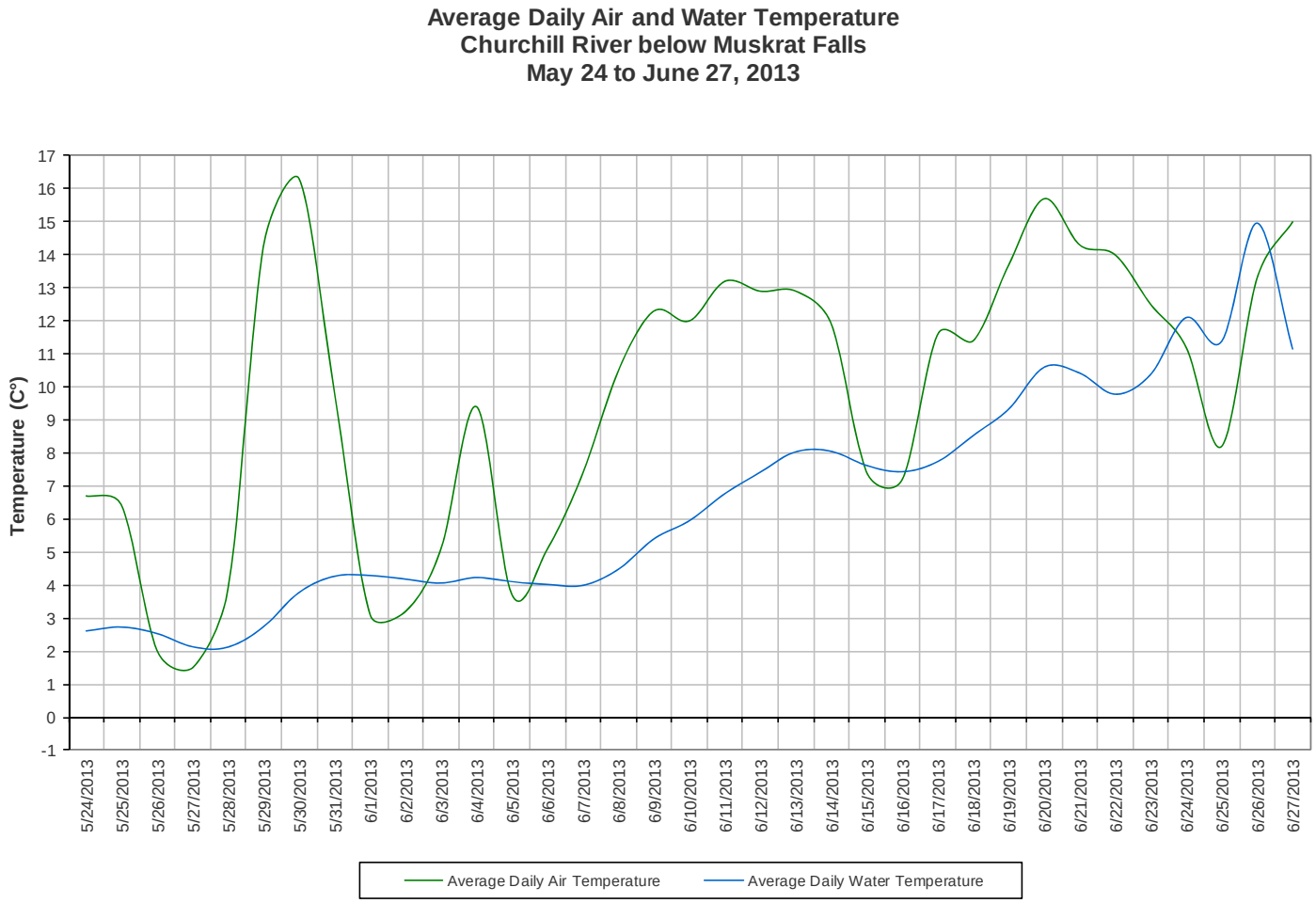


Figure 24: Average daily air and water temperature at Churchill River below Muskrat Falls

(weather data recorded at Goose Bay)

- pH ranges between 6.25 and 6.66 pH units (Figure 25). pH is generally stable at this station.
- All values during the deployment are within of below the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 25).
- There is a decrease in pH on June 15-16. This decrease corresponds with a rainfall event (~20mm) and a decrease in average daily temperature (~8°C). This event is indicated in red on Figure 25.

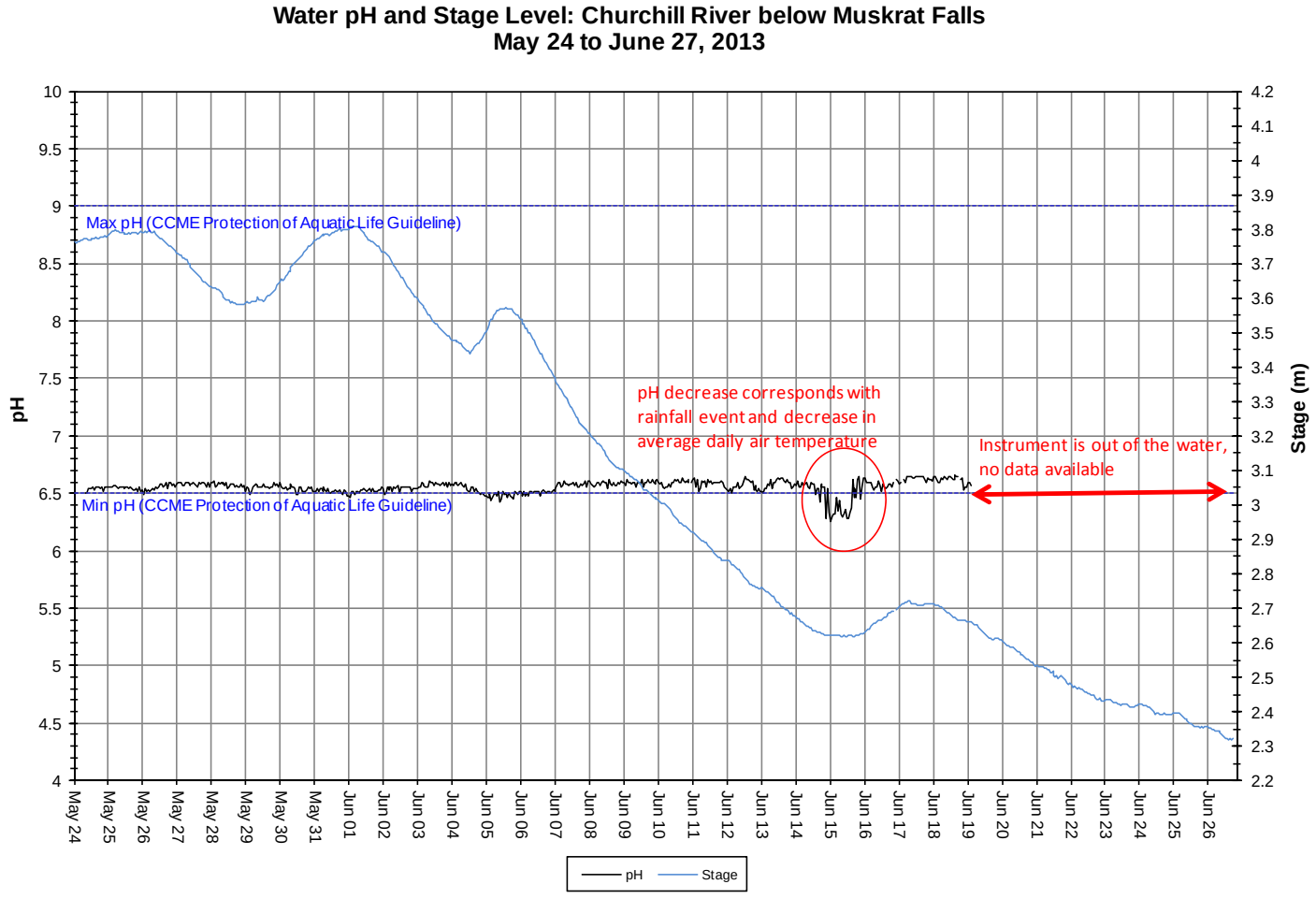


Figure 25: pH and stage level at Churchill River below Muskrat Falls

- Specific conductance ranges between 11.6µS/cm and 16.9µS/cm during the deployment period, averaging 13.5µS/cm (Figure 26).
- Specific conductivity is increasing slightly throughout the deployment period as stage is decreasing rapidly.
- On June 6, 9 and 18, specific conductivity increases sharply by 2-3µS/cm for 1 hour periods. It is unknown what caused these increases.
- Stage is included in Figure 26 to illustrate the inverse relationship between conductivity and water level. Generally, as stage levels decrease, specific conductivity generally increases due to the increasing concentration of dissolved solids in the water column. Inversely, when stage increases, specific conductivity usually decreases as the concentration of dissolved solids is diluted. This trend is noticeable at this station and is indicated by the red arrows on Figure 26.

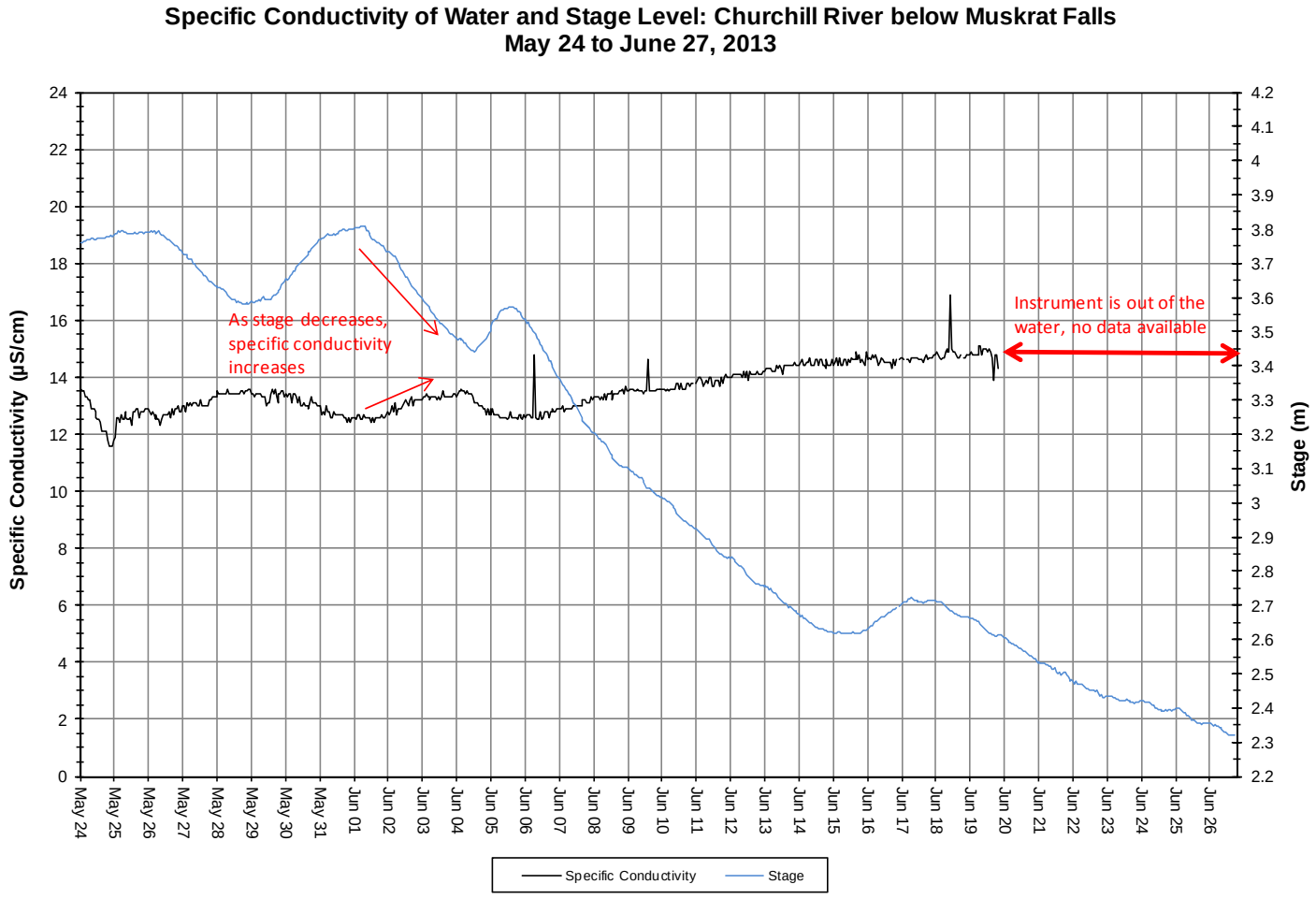


Figure 26: Specific conductivity and stage level at Churchill River below Muskrat Falls

- Dissolved oxygen content ranges between 11.86mg/l and 14.90mg/l. The saturation of dissolved oxygen ranges from 99.1% to 110.9% (Figure 27).
- All values were above both the minimum CCME Guidelines for the Protection of Cold Water Biota at Other Life Stage of 6.5mg/l and at Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 27.
- Dissolved oxygen content is decreasing throughout the deployment period. This trend is expected given the warming air and water temperatures (Figure 24). Dissolved oxygen is typically higher at this station compared to the other stations further upstream due to the addition of oxygen to the water at Muskrat Falls.

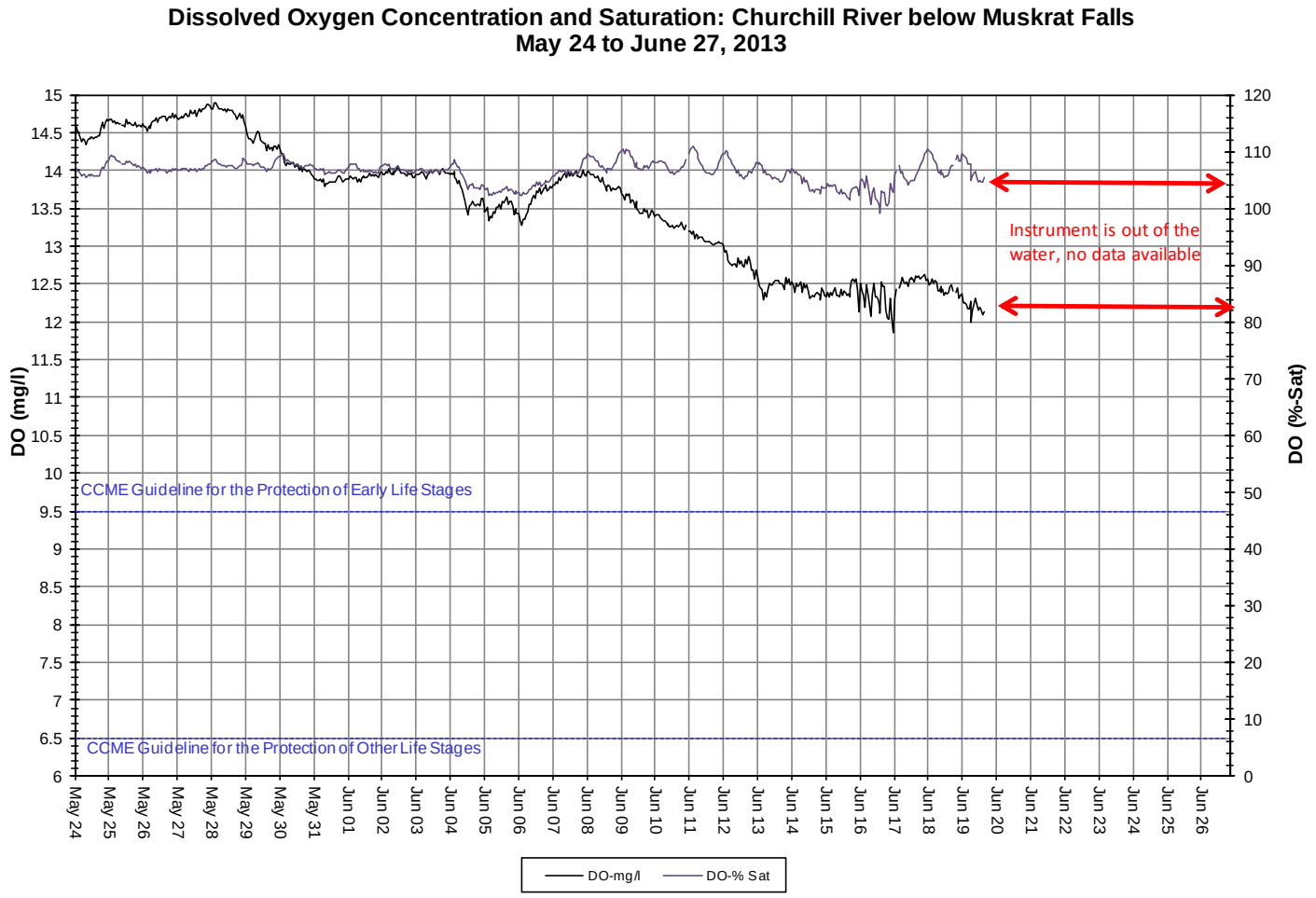


Figure 27: Dissolved oxygen and percent saturation at Churchill River below Muskrat Falls

- Turbidity ranges between 3.2NTU and 140NTU throughout the deployment period (Figure 28). A median value of 11.9NTU indicates there is a consistent natural background turbidity value at this station. This trend is typical at this station.
- Turbidity increases above the natural background level occurring on May 29-31 and June 12-13 do not correspond with rainfall events recorded in the area. It is unknown what caused these increases. Conversely, turbidity increases from June 4-7 do correspond with rainfall events recorded on June 3-5 and may in part be related to the turbidity increase captured at this time.
- Turbidity values recorded in the week prior to the instrument becoming exposed to air have also been removed from the data set due to inaccuracies. The turbidity sensor is highly affected by the wave action at the shoreline as the water level drops.

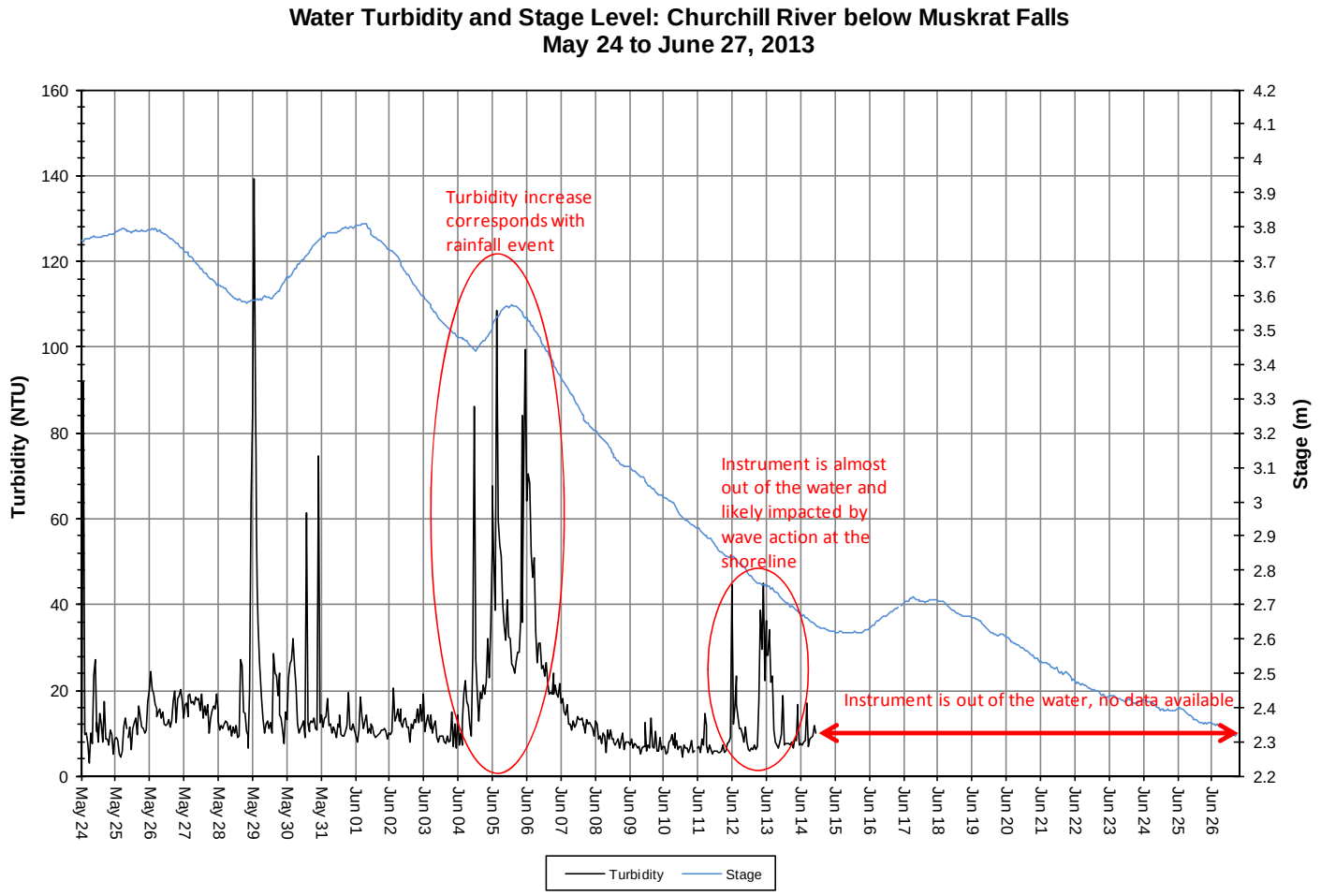


Figure 28: Turbidity and stage level at Churchill River below Muskrat Falls

- Chlorophyll is now being measured at the station below Muskrat Falls (Figure 29). The sensor is undergoing testing and data cannot be validated until further testing is completed. The sensor may require additional calibration by an instrument technician.

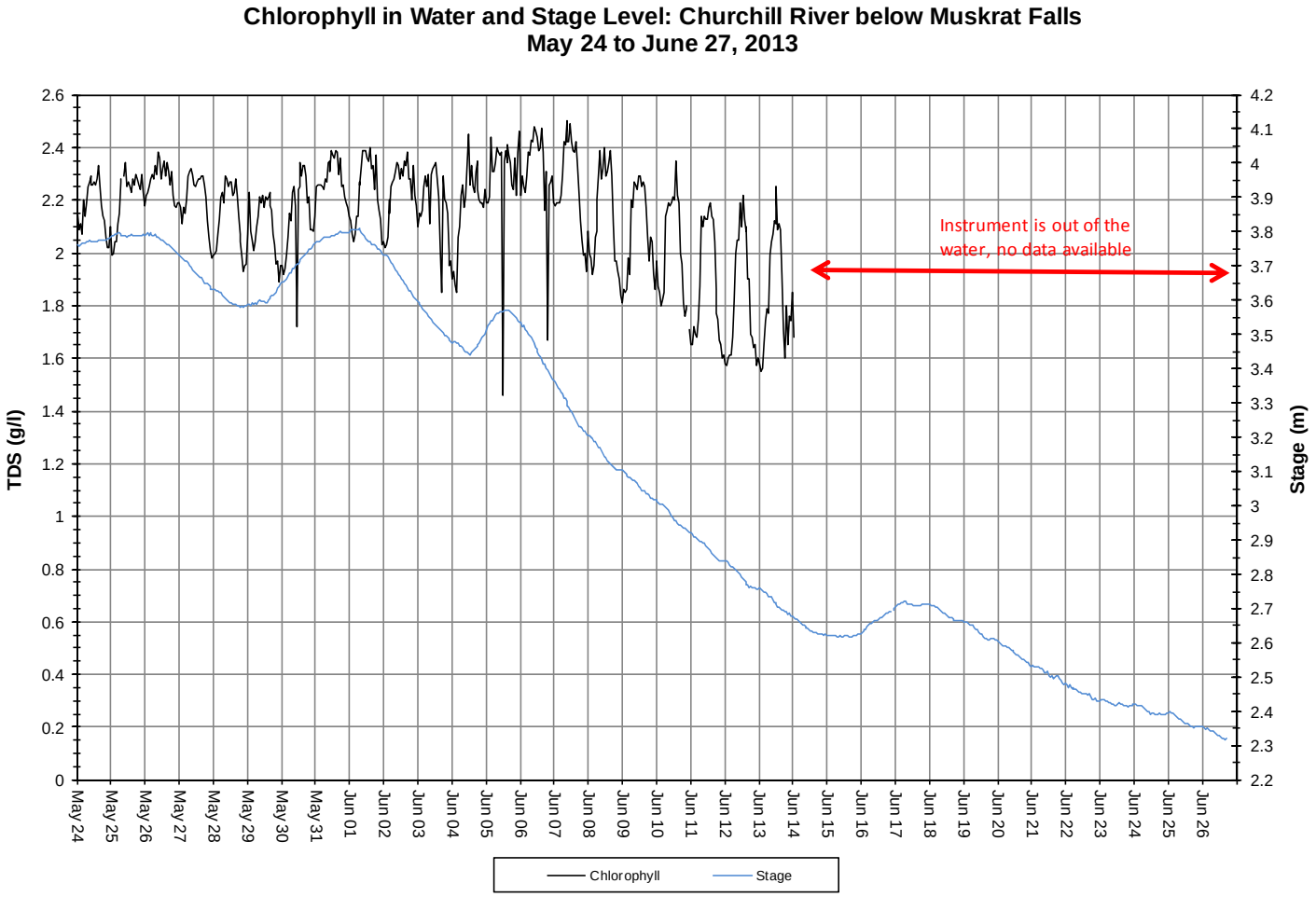


Figure 29: Chlorophyll and stage level at Churchill River below Muskrat Falls

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 30). Stage is decreasing throughout the deployment period. Precipitation amounts are moderate in frequency and low in magnitude. Stage ranges between 2.32m and 3.81m, a difference of 1.49m.

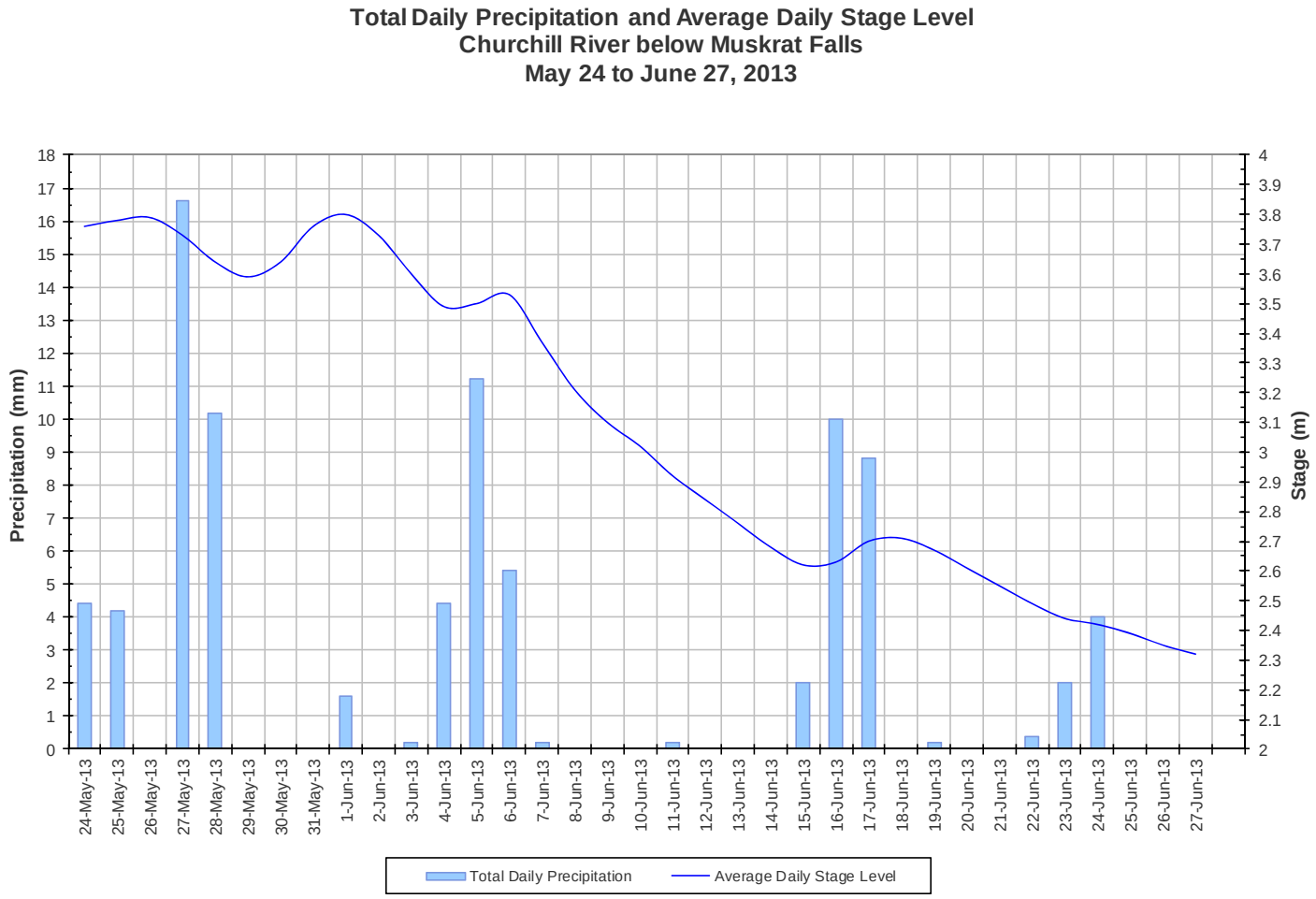


Figure 30: Daily precipitation and average daily stage level at Churchill River below Muskrat Falls (weather data recorded at Goose Bay)

Churchill River at English Point

- Water temperature ranges from 2.00°C to 15.60°C during the deployment period (Figure 31).
- Water temperature is increasing throughout the deployment period. This trend is expected given the warming ambient air temperatures in the spring season (Figure 32). Water temperature fluctuates diurnally.

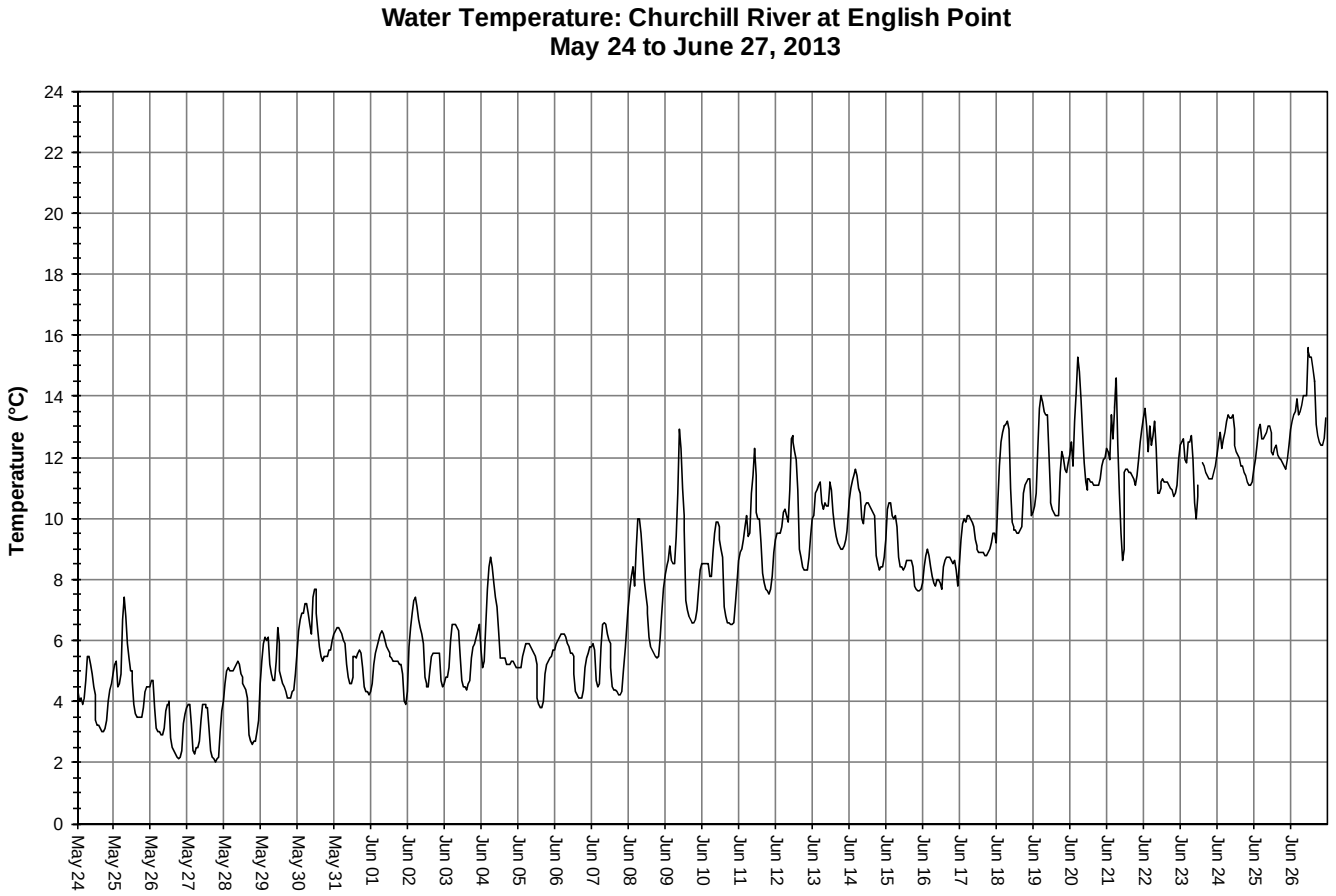


Figure 31: Water temperature at Churchill River at English Point

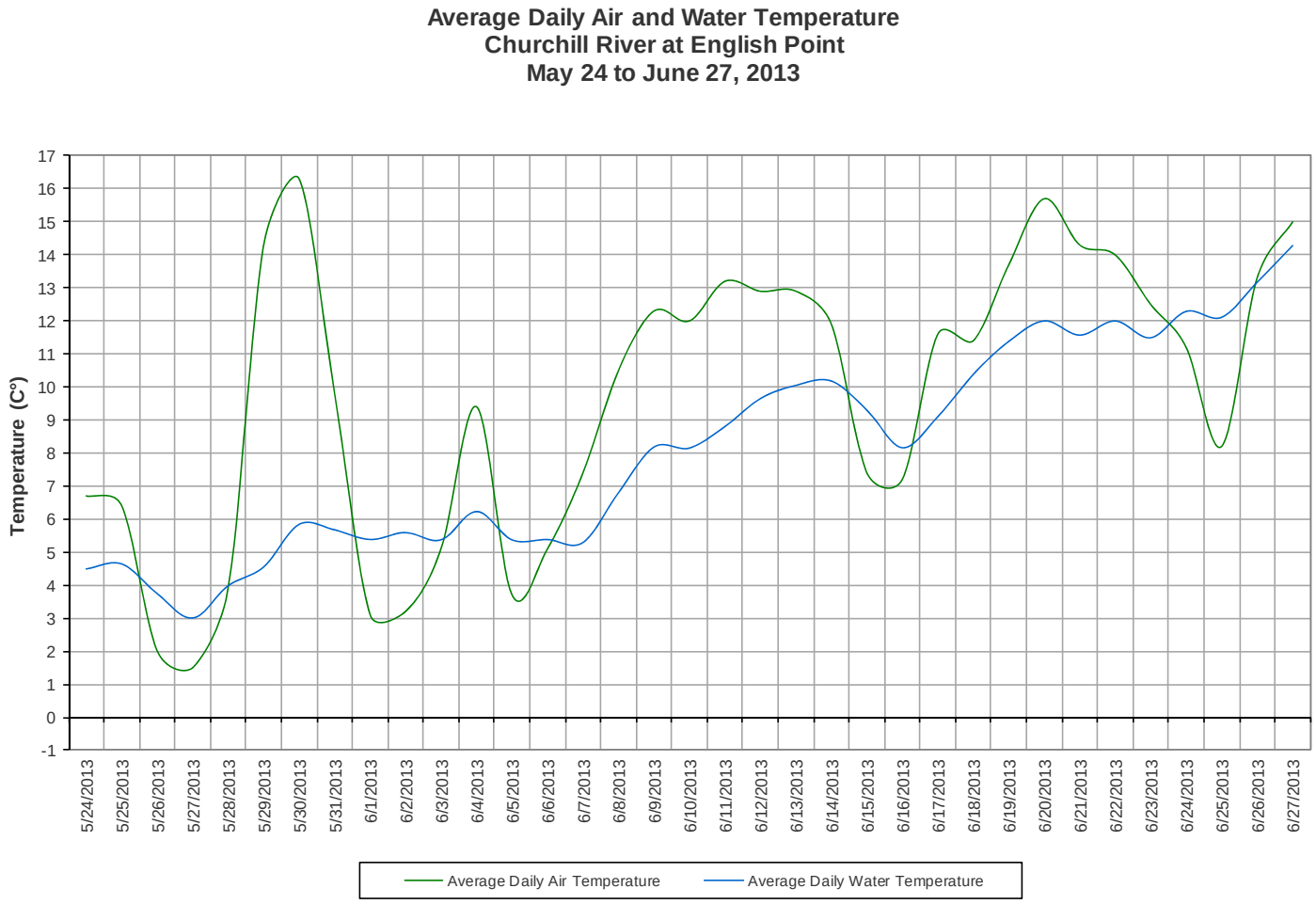


Figure 32: Average daily air and water temperature at Churchill River at English Point

(weather data recorded at Goose Bay)

- pH ranges between 6.44 and 6.93pH units (Figure 33). pH generally fluctuates on a daily basis.
- All values during the deployment are within or just slightly below the CCME Guidelines for the Protection of Aquatic Life (indicated in blue on Figure 33).

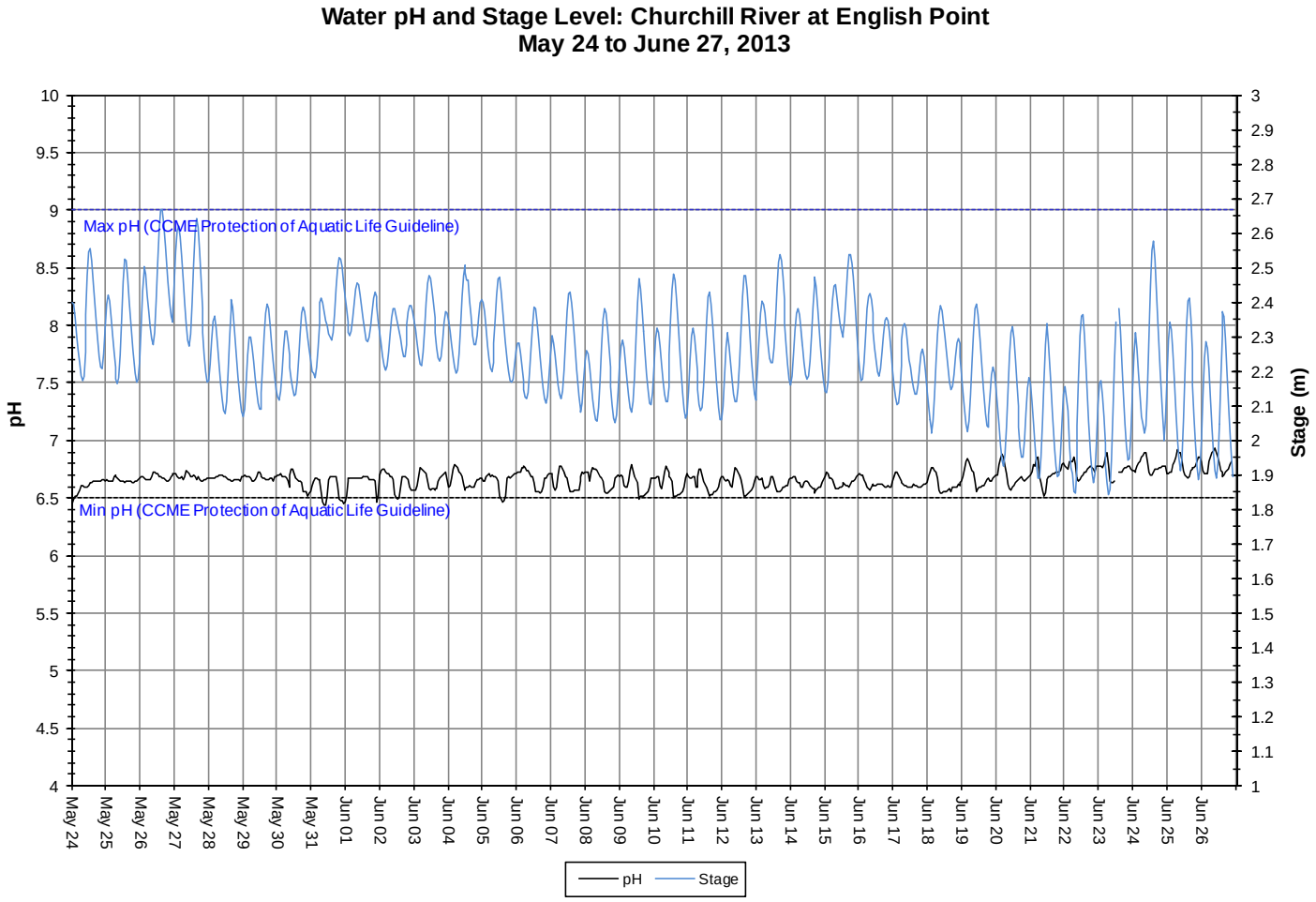


Figure 33: pH and stage level at Churchill River at English Point

- Specific conductance ranges between 11.2µS/cm and 51.5µS/cm during the deployment period, averaging 24.9µS/cm (Figure 34).
- Specific conductivity fluctuates considerably at this location due to the tidal influences of the Atlantic Ocean. As the tide comes in, the specific conductivity increases as the dissolved solids and salinity increase, and vice versa as the tide goes out. This increase and decrease in specific conductivity and stage occurs twice daily. This pattern is generally consistent throughout the deployment period.

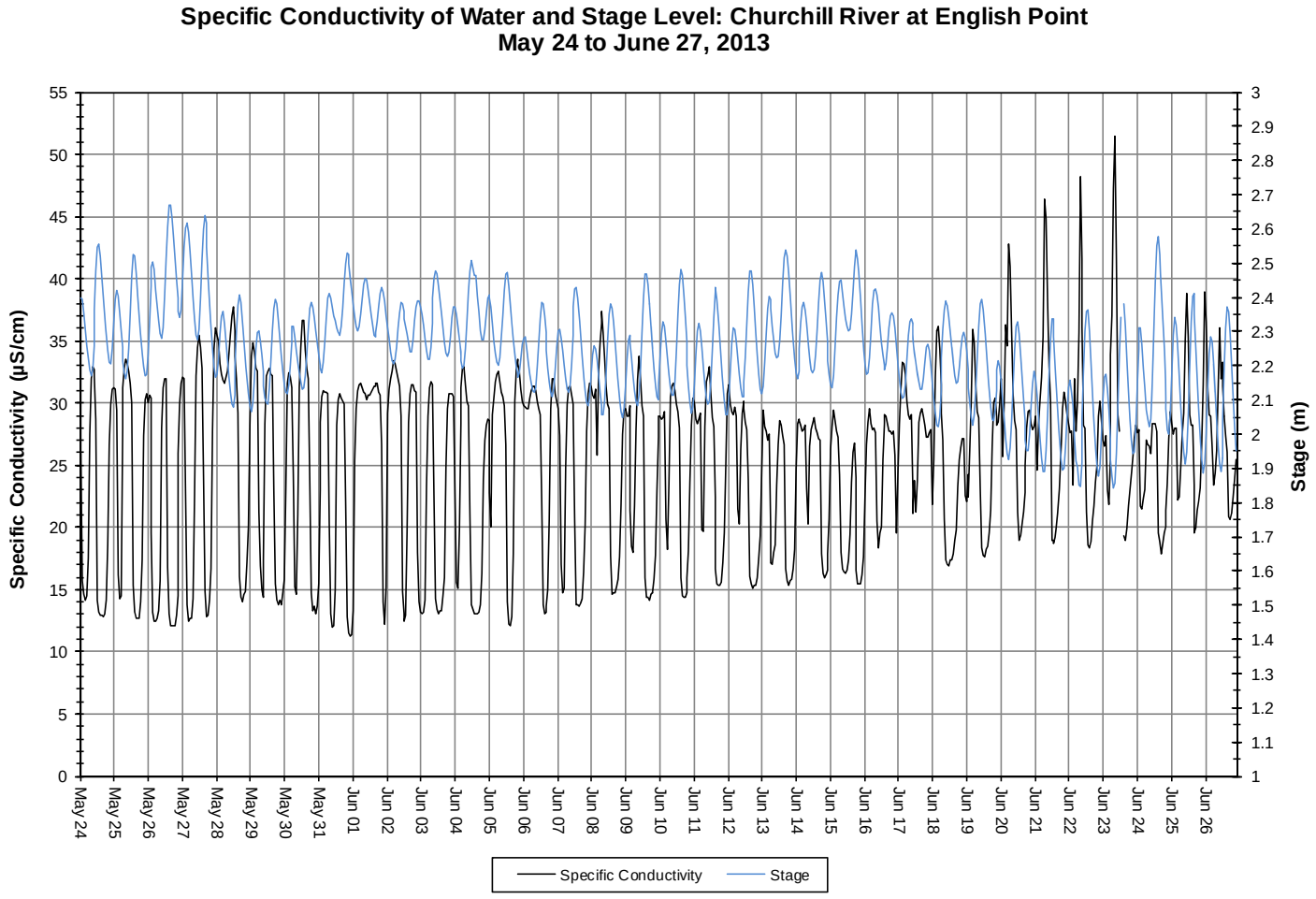


Figure 34: Specific conductivity and stage level at Churchill River at English Point

- Dissolved oxygen content ranges between 10.32mg/l and 14.17mg/l. The saturation of dissolved oxygen ranges from 91.2% to 111.9% (Figure 35).
- All values were above both the minimum CCME Guidelines for the Protection of Cold Water Biota at Other Life Stage of 6.5mg/l and at Early Life Stages of 9.5mg/l. The guidelines are indicated in blue on Figure 35.
- Dissolved oxygen content is decreasing throughout the deployment period. This trend is expected given the warming air and water temperatures (Figure 32).

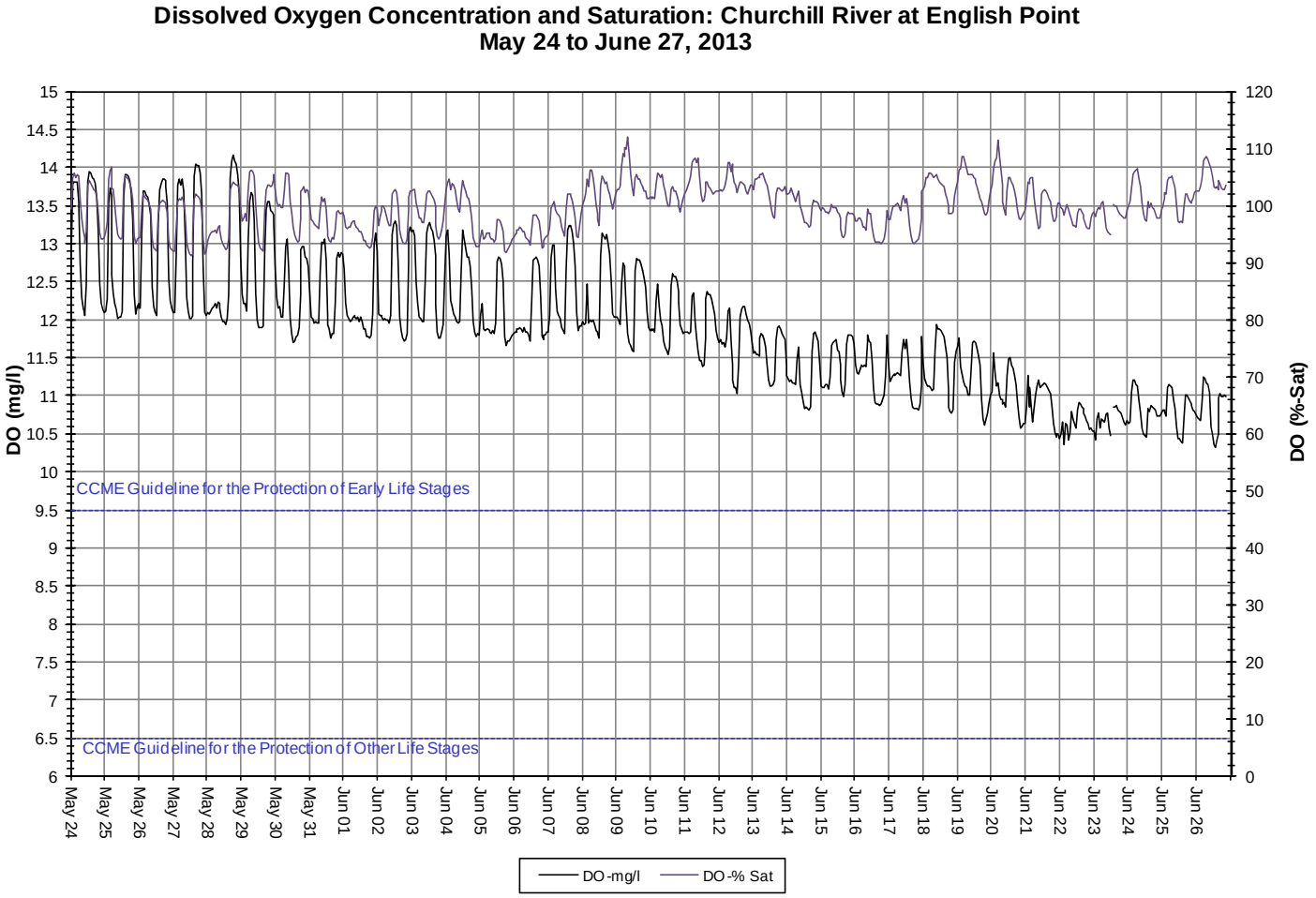


Figure 35: Dissolved oxygen and percent saturation at Churchill River at English Point

- Turbidity ranges between 1.5NTU and 128NTU throughout the deployment period (Figure 36). A median value of 11.8NTU indicates there is a consistent natural background turbidity value at this station. This trend is typical at this station.
- Turbidity values change rapidly at this station from hour to hour. There is a number of turbidity increases recorded during the deployment period that correspond with rainfall amounts. Rainfall events recorded on May 26-27, June 3-5, 14-16 and 21-23 each correspond with increases in turbidity. These events are indicated in red on Figure 36.

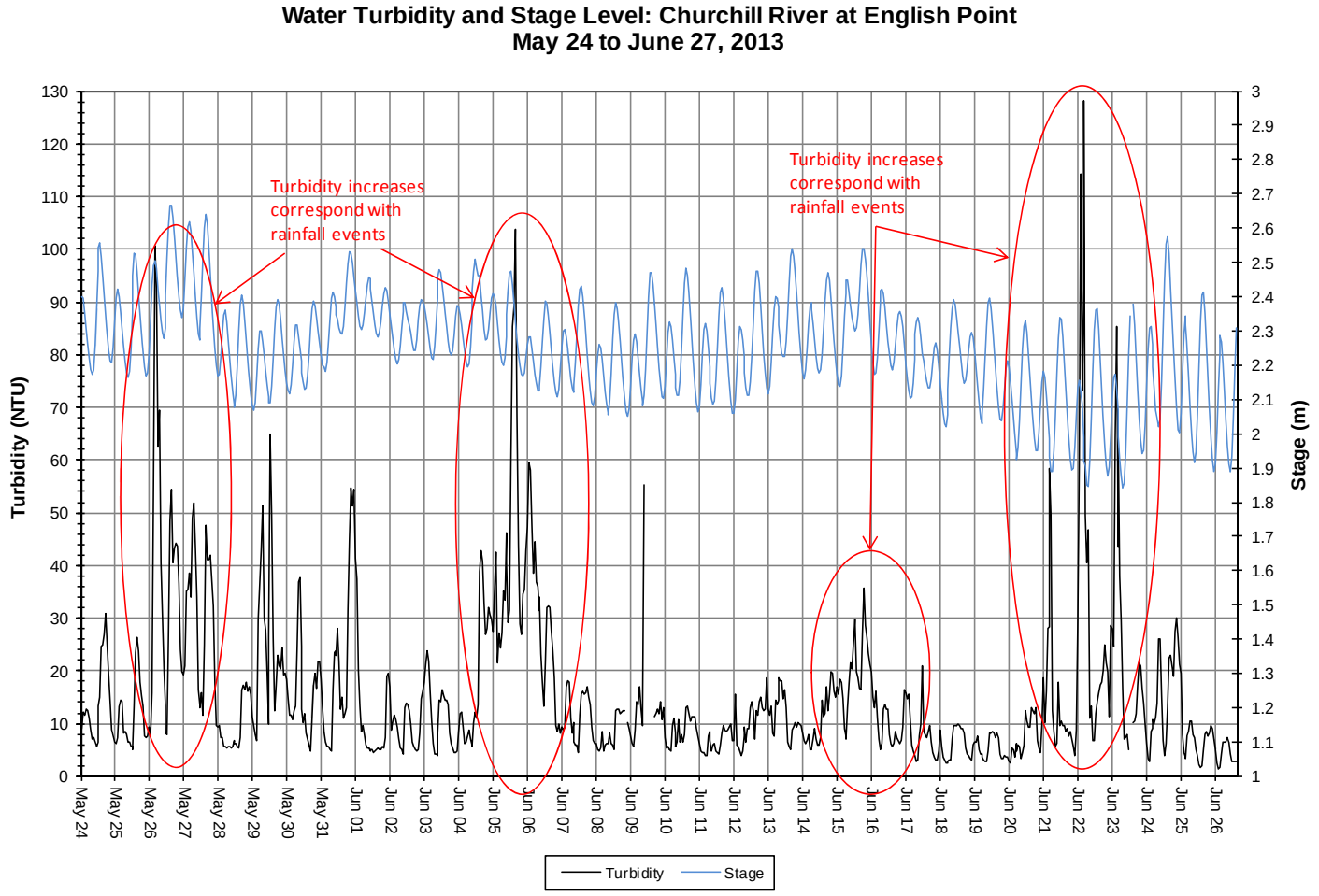


Figure 36: Turbidity and stage level at Churchill River at English Point

- Stage and precipitation are graphed below to show the relationship between rainfall and water level (Figure 37). Stage is decreasing gradually throughout the deployment period. Precipitation amounts are moderate in frequency and low in magnitude. Stage ranges between 1.84m and 2.67m, a difference of 0.83m.

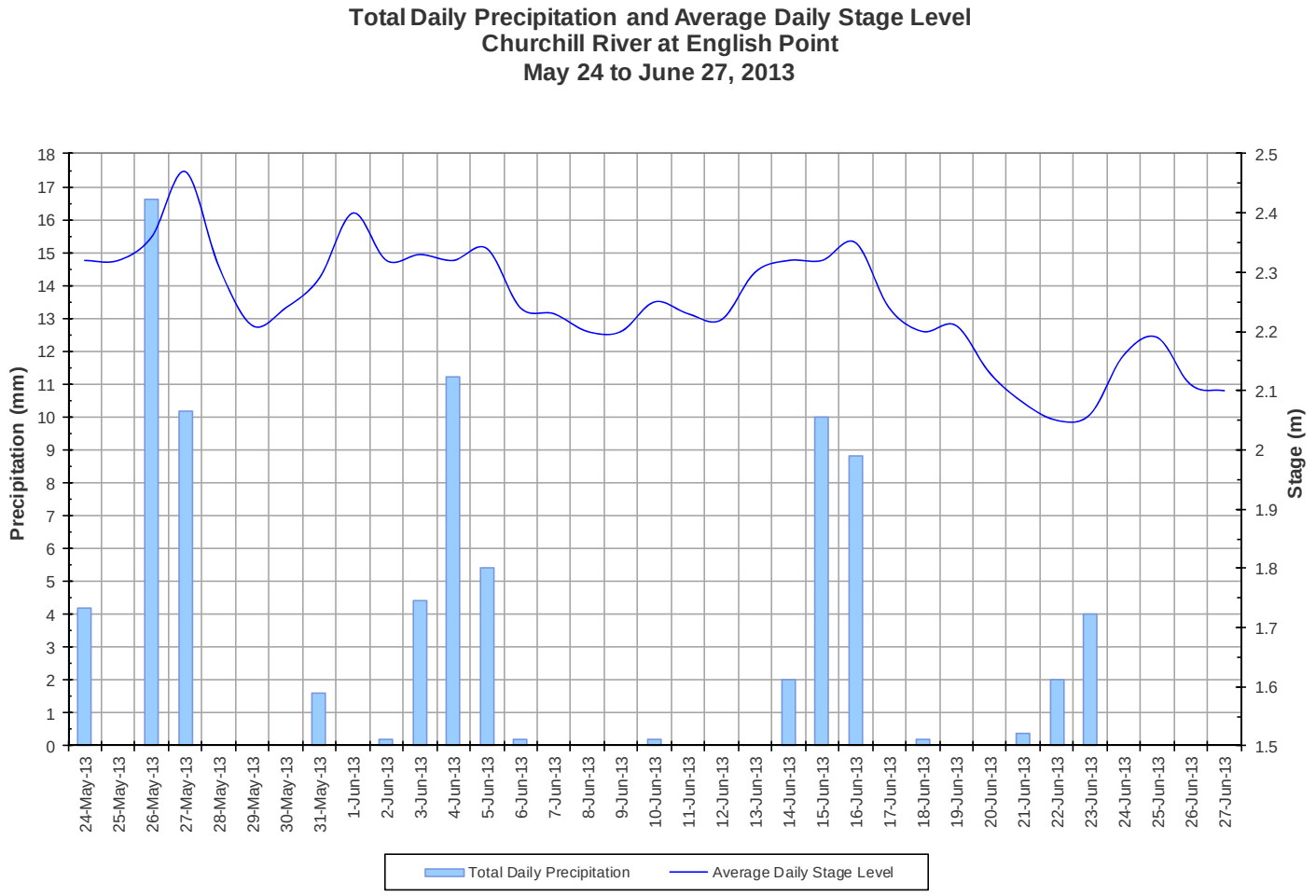
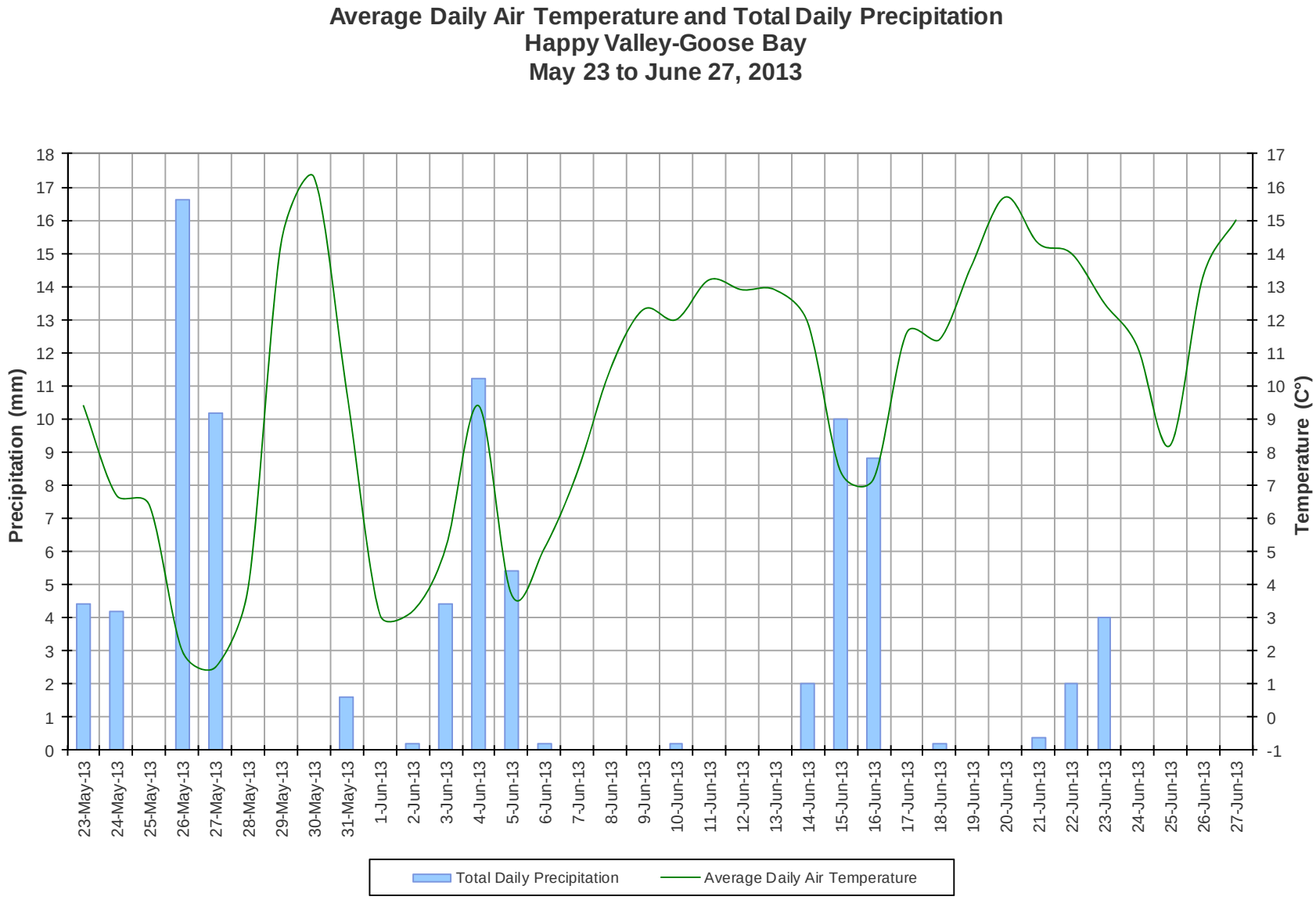


Figure 37: Daily precipitation and average daily stage level at Churchill River at English Point (weather data recorded at Goose Bay)

Conclusions

- Instruments at five water quality monitoring stations on the Lower Churchill River were deployed from May 23/24 to June 26/27, 2013. In most cases, weather related events or significant drops in water level could be used to explain the fluctuations.
- Stage levels decreased at all stations throughout the deployment period between 0.83m and 2.43m. The significant drop in water level throughout the entire network left the instruments exposed to air at the station below Metchin River on June 9, at above Muskrat Falls on June 12 and below Muskrat Falls on June 19. The instruments at the station below Grizzle Rapids and at English Point were retrieved from very shallow water.
- Water temperature was increasing at all stations throughout the deployment period due to the warming ambient air temperatures in the region in the spring season. Water temperature typically ranged between 2°C and 15°C.
- pH is generally neutral and stable at all stations along the Lower Churchill River ranging between 6.25 and 7.10 pH units. pH values were generally within the recommended CCME Guidelines for the Protection of Aquatic Life and consistent at all stations. At the stations above and below Muskrat Falls and at English Point, pH values were either just above or just below the lower recommended values for pH as suggested by the guidelines. At the station below Muskrat Falls, a noticeable drop in pH corresponds with cool air temperatures and a rainfall event.
- Specific conductivity was increasing at all stations and corresponded well with the decreasing stage levels. Specific conductivity typically averaged between 12µS/cm and 17µS/cm at the station below Metchin River, below Grizzle Rapids and above and below Muskrat Falls. The station at English Point experiences tidal influences from the Atlantic Ocean and the specific conductivity averages higher at 25µS/cm.
- Dissolved oxygen content was decreasing throughout the deployment period as it is inversely related to water temperature. Values ranged between 10.32mg/l and 14.90mg/l. All values were above both the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Other Life Stages at 6.5mg/l and Early Life Stages of 9.5mg/l. The station below Muskrat Falls consistently has high dissolved oxygen content due to the location of the Muskrat Falls, 6km upstream.
- Turbidity values at the stations below Metchin River and below Grizzle Rapids remained mostly at 0NTU throughout the deployment period which is typical of these stations. Background turbidity values were 9.3NTU, 11.9NTU and 11.8NTU at the stations above and below Muskrat Falls and at English Point, respectively. There are a number of turbidity increases at both stations as well, which most times correspond with precipitation events.

Appendix 1 – Weather Data – Environment Canada Historical Weather and Climate Database



Average Daily Air Temperature and Total Daily Precipitation
Churchill Falls
May 23 to June 27, 2013